DEVELOPMENT OF A RURAL FREEWAY LEVEL OF SERVICE MODEL BASED UPON TRAVELER PERCEPTION

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

2005

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Scott Washburn, and my committee members Dr. Lily Elefteriadou and Mr. Bill Sampson.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

LIST OF TABLES vi

LIST OF FIGURES vii

ABSTRACT viii

CHAPTER

1 INTRODUCTION 1

Background 1
Problem Statement 2
Research Objective and Tasks 4
Chapter Organization 4

2 LITERATURE REVIEW 6

HCM Freeway LOS Methodology 6
Studies Investigating Traveler Perception of LOS 8

3 RESEARCH APPROACH 16

Alternative Survey Methods 16
Video Data Collection 19
Survey Sessions 30

4 ANALYSIS AND RESULTS 35

Analysis Method 35
Statistical Analysis 39

5 CONCLUSIONS AND RECOMMENDATIONS 45

Data Collection and Video Clip Creation 45
Statistical Analysis 46

Study Limitations and Recommendations for Further Research 47

REFERENCES 49

APPENDIX

A LOCATIONS OF DATA COLLECTION SITES 51

B VIDEO CLIP SCREENSHOTS 55

C RURAL FREEWAY TRIP QUALITY SURVEY FORM 63

D SAMPLE LOOP DETECTOR DATA 68

BIOGRAPHICAL SKETCH 73

LIST OF TABLES

1. HCM Level of Service Thresholds 8

2. Data Collection Sites and Traffic Data 21

3. Data Collection Times, Locations, and Directions 24

4. Traffic Data for 13 Video Clips 29

5. Clip Sites, Dates, and Times 30

6. Dates and Locations of Survey Sessions 33

7. Density Model Estimation Results 40

8. Comparison of Estimated and HCM LOS Thresholds 41

9. Traffic Characteristics Model Estimation Results 42

10. Level of Service Model Estimation Results 43

11. Realism of Video Survey Responses 46

LIST OF FIGURES

1. Camera Setup-Front View, Side View, Speedometer 23

2. In-Vehicle Equipment Setup 24

3. Setup of a Survey Session 26

4. Sample Video Screenshot 26

5. Illustration of an Ordered Probability Model 37

6. Illustration of an Ordered Probability Model with an Increase in $\boldsymbol{\beta}$ 38

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Engineering

DEVELOPMENT OF A RURAL FREEWAY LEVEL OF SERVICE MODEL BASED UPON TRAVELER PERCEPTION

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May 2005

Chair: Scott Washburn
Major Department: Civil and Coastal Engineering

The concept of Level of Service (LOS) is meant to reflect the trip quality a traveler will experience on a roadway or other transportation facility. Despite this, there have been relatively few studies that have tried to measure the association of prescribed level of service assessment methods with traveler perceptions. The objective of this study is to provide insight into how road users perceive their trip quality on rural freeways, and to examine how the existing service measure (density) relates to these travelers' perceived trip quality.

Study participants were shown a series of video clips of rural freeway travel from a driver's perspective, then filled out survey forms indicating their opinion of the trip quality provided by the conditions in the video clip, and ranked these video clips on a scale from 'Excellent' to 'Very Poor'. In addition, the survey participants were asked to give background information about themselves and their driving habits in case these factors also turned out to be significant in influencing perceived trip quality. These video clips were matched with inductance loop detector data that were collected simultaneously at the data

collection sites, in order to see how well the existing service measure (density) corresponded to the participants' rankings.

The data from the surveys were analyzed using an ordered probability model to determine which factors influenced the participants' decisions and how. Three models were created. The first model used only density as a predictive factor. The second took into account only roadway and traffic characteristics, and the third examined all the significant factors that could be gathered from the survey. The 'density only' model showed that density is indeed a strong indicator of travelers' perceptions of trip quality. A set of LOS thresholds was also calculated using the survey participants' responses. While the survey thresholds and the HCM thresholds had similar values for facility failure, the intermediate thresholds estimated from the survey participants' responses were noticeably lower than the HCM thresholds. This suggests that travelers' tolerance of congestion is lower on rural freeways than the HCM indicates. The other models showed the significance of other factors in the perception of trip quality in addition to density, such as socio-economic information and personal driving habits.

This study provided some preliminary insight into travelers' perception of trip quality, but further study is needed. It is suggested that more research be conducted regarding the effects of different factors on the perception of trip quality, such as a more diverse population sampling. Eventually, the results from this type of video-based study should also be compared to results obtained from a comparable in-field driving experiment. This study indicates the need for a further exploration into the differences between urban and rural freeways, and possibly a different set of thresholds for rural freeways.

CHAPTER 1
INTRODUCTION

Background

Transportation engineers are responsible for targeting roadway infrastructure improvements where they will have the most beneficial effect. Since the capital available for these improvements is limited, engineers must carefully select the projects they choose to fund so that investments will have the best cost-benefit ratio. In a large part these decisions are guided by the procedures and methodologies found in the *Highway Capacity Manual* (HCM) [1]. The HCM is considered to be the definitive reference guide for traffic operations and analysis in the United States. The procedures in the HCM are used to estimate the operational performance of a variety of transportation facilities (e.g., signalized intersections, two-lane highways) and the corresponding level of service (LOS). The assignment of a LOS is based on designated performance measures and corresponding threshold values for individual facilities. The HCM is published by the Transportation Research Board (TRB) and its development and maintenance is the responsibility of the Highway Capacity and Quality of Service (HCQS) committee of the TRB. The current edition of the HCM was published in 2000.

The concept of LOS is a foundation of the HCM. The LOS of a facility is used in the HCM as a qualitative indicator of the operating conditions being experienced by travelers of that facility, under specific roadway, traffic, and control conditions. The HCM describes LOS as "A qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience." LOS is divided into six categories, A through F in the 2000 HCM. LOS A indicates excellent service and LOS F indicates extremely poor service. An analysis yielding LOS A would indicate that the facility is performing extremely well, with low volumes and little congestion. If an analysis shows a facility to be performing at LOS C, it is in the middle range of congestion. If a facility is at LOS E, it is still permitting traffic flow but is experiencing significant delays with conditions approaching capacity. At LOS F, a facility is experiencing oversaturated conditions and the demand has exceeded the capacity of the facility.

Problem Statement

The performance measures that are used to calculate LOS for a facility are referred to as service measures. The currently designated service measure(s) for each facility is (are) based on the collective experience and judgment of the members of the HCQS committee. The same is true with the selection of the threshold values for the various LOS designations. There is currently no quantitative procedure to define which values are used as LOS thresholds. The LOS determination process, therefore, is based on the perspective of transportation professionals. The selection of service measures by the HCQS committee is, however, guided by two principles: 1) the service measure for each facility should represent speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience in a manner most appropriate to characterizing quality of service for the particular facility being analyzed, and 2) the service measure chosen for a facility should be sensitive to traffic flow such that the service measure accurately describes the degree of congestion experienced by users of the facility [2].

The 1985 HCM described LOS as “A qualitative measure that characterizes operational conditions within a traffic stream and their perception by motorists and passengers. The descriptions of individual levels of service characterize these conditions in terms of factors such as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience” [3]. This statement indicates that the selection of performance measures and thresholds for the determination of level of service should be consistent with how operating conditions are perceived by the traveling public. Until recently, road users’ perceptions of quality of service were rarely compared to the LOS assigned to a facility by the HCM, despite the above definition emphasizing the importance of reflecting road users’ perceived quality of service.

There have been suggestions from within the HCQS committee that a new approach needs to be explored when selecting a service measure for a facility. Instead of the measure and corresponding thresholds that transportation professionals (the HCQS committee) believe represent the quality of service as perceived by travelers, the public’s opinion should be taken into account so as to determine what measure or measures they associate with quality of service on a transportation facility. Under the current methodology, the HCQS committee believed that the service measures were highly correlated with public perception, but this was not known for sure [4]. Since billions of dollars of transportation investment decisions are made every year based upon the outcome of HCM level of service analyses, it is essential that the transportation engineers' assessments of the impact of these investments be consistent with traveler perception of the investment impacts.

Research Objective and Tasks

The objective of this study was to develop a model for assessing the LOS of a roadway facility that takes into account the road user's perceived quality of service. Specifically, this study was focused on rural freeways.

The following tasks were carried out in supporting the above research objective.

- Determine appropriate rural freeway sites to perform field data collection
- Collect video of roadway and traffic conditions from these sites
- Collect traffic data from count stations at these sites
- Produce video clips to be shown to survey participants
- Develop a survey instrument
- Recruit survey participants
- Conduct survey sessions
- Perform an analysis of survey responses
- Develop a level of service model

Chapter Organization

Chapter 2 contains an overview of the current HCM freeway analysis methodology as well as an overview of relevant literature. Chapter 3 describes the research approach for this study, including the field data collection, survey instrument development, survey response data collection, and the statistical analysis method used to analyze the data. Chapter 4 contains the analysis results. Chapter 5 contains the conclusions and recommendations. Additionally, several appendices with supporting data and information are included.

CHAPTER 2
LITERATURE REVIEW

The *Highway Capacity Manual* [1] states that the level of service of a roadway section should accurately reflect the perceptions of travelers, yet the current methodology does not directly take these perceptions into account. There have been some recent studies performed seeking travelers' opinions about what factors and qualities are important to them in assessing the quality of their trip. A literature review was conducted to identify these studies and note their findings with regard to the traveler's perception of LOS.

HCM Freeway LOS Methodology

A freeway is a section of divided roadway with controlled access and two or more lanes in one direction. Within this definition there are significant differences between urban and rural freeways. Rural freeways have greater distances between interchanges than urban freeways, higher speed limits than urban freeways, and a higher percentage of social and recreational trips than urban freeways. Urban freeways have a higher percentage of work and shopping trips than rural freeways. Despite these differences, urban and rural freeways both use density as their service measure with the same thresholds for LOS.

Traveler expectations and perceptions of quality of service are different for rural and urban freeways. While urban freeways experience the full range of LOS conditions from A to F, rural freeways rarely drop below LOS C. Rural freeway travelers have come to expect these higher levels of service, therefore while urban freeway travelers are concerned with their overall travel time and the reliability of this travel time, rural freeway drivers take travel time for granted. Urban freeway drivers expect their ability to change lanes to be restricted, while a restricted ability to change lanes negatively impacts a rural freeway user's perceived quality of service [5].

The original HCM had a basic three-point scale to define level of capacity. In 1963 the Level of Service concept was introduced and replaced the previous scale. In 1965 the six-point LOS scale (from A to F) was introduced. In 1985 this six-point scale was redefined to use traffic density (vehicles per unit length of roadway) as the service measure for defining LOS on freeway sections. This is the method that is still used today. Although the concept of LOS is meant to reflect the operational conditions as perceived by motorists, no freeway LOS methodology in the history of the HCM has been based on driver perception studies. Therefore, there can be no way to make sure that the LOS thresholds freeways (as well as any other type of facility) accurately reflect users' perception of the quality of service they receive.

Under the existing LOS methodology, rural and urban freeways have the same service measure – density, as well as the same thresholds for each rank on the LOS scale. These thresholds for all freeway sections are shown in the table below.

Do these thresholds accurately reflect the quality of service perceived by travelers on all freeways, urban and rural? In particular, the studies by Hostovsky [5] and Washburn [4] indicate that rural freeway travelers may judge the quality of their trip based on different qualities and criteria. A potential outcome of this study is a set of LOS thresholds unique to rural freeways. This idea of differing service measures for different categories of a specific facility type is not a new one. Currently there are two service

Table 1. HCM Level of Service Thresholds

Level of Service	**Density (pc/mi/ln)**
A	0-11
B	11-18
C	18-26
D	26-35
E	35-45
F	> 45

measures used for assessing the LOS of a two-lane highway. These classes share a common service measure, but the thresholds are different (one of the classes also uses an additional service measure). In addition, the HCM procedure for analyzing arterial streets uses the same service measure for all arterial streets but includes four sets of thresholds for four different classifications of arterials [1].

Studies Investigating Traveler Perception of LOS

A study by Pécheux et al. [6] noted that the Transportation Research Board's Committee on Highway Capacity and Quality of Service recognized a need to improve the HCM methodology of assessing LOS. Specifically, concerns were raised that the LOS of a roadway section did not correspond to road users' perceptions. The authors felt that for LOS to accurately reflect travelers' perception of quality of service they would first have to find out what performance measures were significant to travelers.

The study method involved test participants driving along a pre-selected 40-minute route, encompassing mostly arterial streets, accompanied by an interviewer and a traffic engineer. The participant would discuss what factors they personally found important to the quality of their trip. Participants identified over 40 factors that were important. These included such factors as intersection efficiency—if the intersection was being utilized by opposing traffic while travelers were waiting, and the aesthetic qualities of the intersection. Both of these topics are not covered by the HCM. The study concluded that more research was needed to focus on traveler perception.

A study by Hostovsky et al. [5] used focus group participants to identify factors important to trip quality on rural freeways and then compared those findings with those from a focus group study using regular urban commuters and commercial truck drivers. The participants in the rural freeway focus group identified three factors that were most important to trip quality—low density, regular (predictable) travel time, and maintaining a steady travel speed. Other topics discussed were the safety issues inherent to the isolated locations of rural freeways, aesthetics, speed differential between cars, the presence of heavy vehicles, and the need for better traveler information.

When compared to the results of a focus group study involving urban commuters, it was found that urban commuters placed high importance on the overall speed of their trip, where rural freeway travelers felt that the ability to choose their speed was a positive. This reflects the fact that urban drivers rarely have the opportunity to choose their speed in the traffic stream, so a faster speed is usually preferable over a slower one. Urban commuters were also not as concerned with the ability to change lanes and move about the facility at will. Most of the urban drivers were happy if they could stay in one lane and maintain a desired speed for their trip. The rural drivers were pleased if the density of the freeway section was low enough to allow movement between lanes and passing at will. This study was significant due to the fact that it recognized the differences in how travelers rate their trip quality on an urban versus a rural freeway. The HCM uses the same methodology for freeways in both types of areas.

A study by Nakamura et al. [7] evaluated traffic flow conditions along an expressway in Japan from a driver's viewpoint. The study intended to quantitatively analyze the relationship between traffic flow conditions, drivers' perceptions, and drivers' behaviors. The field data portion of this study was intended to collect data on drivers' behavior and perception under various flow conditions. Drivers had a video camera mounted in their own vehicle and were asked to drive a section along an expressway. After each trip the subject was asked to complete a survey about the traffic flow conditions. Twenty-two subject vehicles were used and 105 surveys were collected. The behavioral data collected was number of lane changes, travel time by lane, and percent time spent following.

This study found that the most important factor influencing drivers' satisfaction with their trip was the traffic flow rate. Other factors affecting trip quality were found to be number of lane changes, and the percent time spent following. Additionally, choosing the LOS based on the driver's level of satisfaction was attempted and then compared to the conventional LOS methodology. The results of this comparison suggested that the traffic conditions on Japanese expressways are not satisfying drivers. The realistic meaning of this result was that if facilities were designed to the driver's satisfaction level rather than the conventional LOS it would require an enormous investment.

Several studies have been identified using road-user surveys and video selections to evaluate LOS methodology. The first study, by Sutaria and Haynes [8], used a road user survey to evaluate the LOS methodology for signalized intersections. Over 300 drivers were shown video clips taken both from a driver's perspective and from an overhead camera at an intersection. The film segments were specifically chosen to represent a specific LOS and were intended to be shown to drivers for one or two signal cycles. The final compilation shown to drivers included both types of view and the clips were put in a random order.

Their road user survey consisted of two parts—a group attitude survey and a film survey. The group attitude survey used a questionnaire, to be answered before the film portion of the survey. The questionnaire included demographic information such as gender, age, and education, as well as questions about the participants' driving experience and the type of roadways the participants usually drove on. They were then asked to give the relative importance of factors including delay, number of stops, traffic congestion, heavy vehicle density, and ability to change lanes as these factors applied to the quality of service at an intersection. After the initial questionnaire the participants were shown the video clips, consisting of a driver's view of a vehicle approaching, waiting, and passing through an intersection. After each of these clips the participants rated the quality of service they felt the intersection provided. At the end of the video portion the participants were again asked to rate the factors important to quality of service at an intersection to see if their initial opinion had changed. In all, 310 drivers participated in this survey.

The results from the survey showed delay to be the most important factor both before and after the film portion of the survey. This study provided the first results that took into account the perceptions of travelers and changed the performance measure used by the HCM to evaluate LOS in the 1985 edition. This study also recommended further similar studies, and for further studies to simultaneously collect video and traffic flow data to allow for accurate measurements of what is depicted on the films.

A study conducted by Pécheux et al. [9] addressed the issue of developing a study method to assess the perceived LOS at signalized intersections. The first objective of all the study methods was to determine how well the current LOS methodology reflects the opinion of road users. The second objective was to determine the factors affecting users' perceptions at signalized intersections.

The participants in this study represented a wide range of ages, education levels, and incomes. The participants were first shown a series of approaches to signalized intersections from a driver's perspective. After being shown a sequence of these clips, the participants were asked to fill out a survey including their attitudes about certain driving situations as well as their socio-economic information. After filling out these surveys the participants were asked to discuss the factors that influenced their perception of quality of service as a group. The study results showed that on average, the participants' delay estimates were fairly accurate, however individual delay perceptions varied significantly. Fifteen factors were identified that contributed significantly to quality of service. Finally, the study found that participants tended to perceive service quality on three or four distinct levels as opposed to the six HCM levels of service.

Another study using video clips and road user surveys was performed by Choocharukul et al. [10] with the intention of evaluating the current HCM methodology of assessing LOS. This study intended to provide a multivariate statistical analysis of the factors that were important to road users' perception of trip quality and to compare those factors to the current performance measures for LOS.

The data for this study were collected at various urban freeways. Cameras mounted on overpasses were used and were focused on sections that included inductance loop detectors. The cameras were focused so that only one direction of travel could be observed. The data from the loop detectors were collected and synchronized with the time of the video clips so the researchers would know the actual traffic flow conditions during the time the video clips were recorded. Two sets of video clips were chosen, each containing twelve clips. Two video clips were used for each HCM LOS designation, A–F, with one clip on the high end of an LOS designation and the other clip at the low end. These designations were determined by the loop detector information.

There were two groups of survey participants in this survey, one consisting of students, transportation professionals, and environmental management professionals, and the other consisting of commercial truck drivers and clerical and support staff. The participants were provided with written descriptions of the six HCM LOS designations (directly from the HCM). They were then asked to view the twelve video clips and rank each of them with the LOS they thought was appropriate for the conditions. The participants were also surveyed for demographic information such as age and education levels, as well as information about their driving habits.

This study used an ordered probit statistical model to assess how users perceive the LOS of the roadway sections. The results of the survey and analysis revealed that perceived levels of service do not closely follow the HCM. Almost all the participants in this study had a lower tolerance for LOS A than the HCM, with the average cut-off for LOS A among the study participants shown to be 7 passenger cars per mile per lane (pc/mi/ln) as opposed to the HCM cutoff of 11 pc/mi/ln. The HCM threshold for LOS F also does not correspond with the findings of this study, with the participants selecting an average of 82 pc/mi/ln as the upper bound of LOS F as opposed to the HCM LOS F of 45 pc/mi/ln. The study also found that factors other than density are likely to influence road users' perception of quality of service. The results from both groups indicated that a freeway with 4 lanes (instead of 6 or 8), an increase in traffic density, and an increase in the standard deviation of vehicle speeds all contributed strongly to a worse perception of LOS. It should be noted that the use of an overhead view of traffic could likely affect survey participants' perceptions in a different way than that of an-vehicle view of traffic and roadway conditions.

Background Study

A study was performed at the University of Florida by Washburn et al. [4] with the objective of discovering what factors are important to drivers when evaluating the quality of their trip on a rural freeway. Several methods were considered for this study (focus groups, video/simulation viewing and review, interviews, etc.) with the final choice being an in-field survey-based approach. Two hundred and thirty-three travelers were surveyed at rest stops and service plazas along rural freeways in Florida. These locations were chosen due to their access to travelers in the process of a rural freeway trip. It was believed that this in-field survey approach would provide more reliable data, than mail-back surveys for example, as the drivers' experiences would still be fresh in their minds when filling out the surveys.

Drivers were asked to rank the factors that contributed to the quality of their trip on a scale from 1 to 7. The most important factor, ranked in the top three 64.3% of the time, was the ability to consistently maintain the desired travel speed. The factor with the next highest ranking was the ability to change lanes freely and pass other vehicles. This was ranked in the top three 33.3% of the time. The third most important factor was the ability to maintain a speed no less than the posted speed limit. This factor was ranked in the top three 33.0% of the time. This preliminary study showed that though density is important to rural freeway travelers, it is not the most important factor in determining trip quality. It also showed that drivers consider many other factors when determining trip quality.

Conclusions

The studies detailed in this chapter have shown that, while some research has been done on travelers' perception of quality of service, there is a need for more study. The current HCM methodologies for evaluating LOS may be insufficient for determining the perceived quality of service from the traveler's point of view. From the studies summarized in this chapter, we can see that it is possible to understand and approximate a traveler's perception of quality of service using the factors that are found to be important to them. This type of research may ultimately assist decision makers when planning for new roadways and roadway improvements.

CHAPTER 3
RESEARCH APPROACH

This chapter will describe the methods used in collecting the sample data for this study as well as the methods used to refine the data for use in public surveys .Detailed within the chapter are the choice of a survey method, the selection of data collection sites, the creation of the survey form, and the process for conducting a road user survey.

Alternative Survey Methods

Common methods of data collection include the following: focus groups, field surveys, in-vehicle surveys driven by a researcher, in-vehicle surveys driven by the research participant, driving simulators, and video surveys.

- Focus Groups – This consists of recruiting test participants in order to arrange a roundtable-type discussion about rural freeway travel. Participants would discuss their rural freeway trip experiences and relate which aspects of rural freeway travel are most important to them when evaluating the quality of their trip. The advantage of a focus group is the relative ease of the survey, there is no video data collection, field work, or liability on the part of the researchers. The disadvantage is that participants may influence each other's responses and one particularly vocal participant could swing the rest of the group towards his or her opinion. Another disadvantage is the lack of a control element for the researchers – there is no one experience on which the participants are basing their opinions, so the researchers can not look at the data or video record to interpret the responses.

Additionally, the potential lack of quantitative feedback upon which to build an analytical model limits researchers in their ability to predict the responses of other travelers faced with similar roadway and traffic conditions.

- Field Surveys – Researchers distribute survey forms at locations frequented by rural freeway travelers, such as rest stops or service plazas. The participants give their opinions on rural freeway travel in a survey form, rating which factors are most important when they judge their trip quality. One advantage to this method is that participants surveyed have recently driven on a rural freeway and have this experience fresh in their mind. Another advantage is that it is relatively easy to recruit participants for this sort of survey; there is always a ready supply of people in this type of location. The disadvantages are similar to the focus group.
- In-Vehicle Surveys (driven by research personnel) – Participants are recruited and driven along a section of rural freeway, then surveyed about their perception of the trip quality. Advantages to this method include – all participants would have the same experience to draw upon for their responses, and there would be no need to attempt to simulate the driving experience as participants would be experiencing the conditions firsthand. The disadvantages to this method include the liability to the researchers should the vehicle be involved in an accident, and the time and effort involved in conducting a survey of this manner. The controllability and repeatability of the conditions are also disadvantages because it is not possible to ensure the same conditions will be experienced by multiple survey participants.

- In-Vehicle Surveys (driven by research participants) – Participants are recruited to drive along a section of rural freeway and provide the researchers with feedback on their trip once they return. Once again this method is advantageous in that it would provide participants with a firsthand look at the conditions involved. The disadvantages to this are similar to the previous method in that there is significant liability attached to a method like this, and this method would be even more time-consuming than the previous one. This method also suffers from the same lack of control and repeatability as any in-car survey.
- Driving Simulator – Participants are put behind the wheel of a real vehicle, but the driving environment is simulated with the use of computer animation and video display monitors. They would then participate in the virtual driving of a rural freeway segment. This would give participants a closer likeness of actual freeway travel without the liability of having them drive a real section themselves. Disadvantages include cost (simulator time is expensive) and the well-documented motion sickness problem for participants (which increases recruitment time and costs).
- Video Surveys – This method involves participants viewing pre-recorded video scenes from actual rural freeway sites. The clips could be from one of two perspectives:
    - Overhead View – A camera placed over the test section of rural freeway records the traffic flow for survey participants to review at a later time. While this method does not give a simulation of actually driving the

freeway section, it does give the participant a broader overview of the traffic stream.

- o Driver's Perspective – A vehicle is equipped with a video camera to record the rural freeway trip from the driver's perspective. This method would better simulate actual rural freeway travel than an overhead view.

After considering all advantages and disadvantages, the method chosen was a video survey from the driver's perspective. This method would allow larger groups of people to be surveyed simultaneously while giving a reasonably accurate depiction of rural freeway travel This method allows for complete control and repeatability of the conditions experienced by the participants, as well as eliminating the liability issues inherent in an in-vehicle survey.

Video Data Collection

The data collection method was developed after selecting the form the survey would take. It included five specific tasks – Site Selection, Equipment and Setup, Video Data Collection, Video Clip Creation, and Loop Data Collection.

Site Selection

The sites at which the video clips were captured were all within Florida. Reasons for this include the proximity to the University of Florida and the access to the Florida Department of Transportation's (FDOT) network of more than 7,500 traffic monitoring stations. The FDOT maintains a network of inductance loop detectors (ILD) along Florida's Intrastate Highway System. There are two types of ILD stations – permanent and portable. The permanent stations were used in this study since they are continuously recording data 24 hours a day, 365 days a year. The portable stations require a data recorder to be hooked up at the location of the ILD station in a roadside cabinet. The permanent stations are telemetered such that data can be downloaded and archived on a daily basis. The data archived from the permanent stations are compiled every year by the FDOT and published on the Florida Traffic Information (FTI) CD. Also included on this CD for each state highway are the number of lanes in each direction, the ILD station type (permanent or portable), a description of the site, the Average Annual Daily Traffic (AADT), the percentage of trucks on the highway, and the peak hour in each direction,

Multiple sites were examined around the state. There were several factors leading to the final site selections. South Florida was excluded due to the limited number of rural freeway segments and the long driving times required to get there and back. Sites west of Tallahassee were also not considered due to driving distance. These conditions hinged upon the availability of suitable sites in north-central Florida. The final sites selected represented a mix of four-lane and six-lane freeways, level and rolling terrain, truck percentages, and a wide range of volume. This information was obtained from the Florida Traffic Information CD published by the FDOT [11]. All sites selected were permanent count stations instead of portable stations. Additional data were used from a similar study conducted months before at the University of Florida. A list of the data collection sites and their associated traffic data follows in Table 2. Maps of the locations of the data collection sites can be found in Appendix A.

Table 2. Data Collection Sites and Traffic Data

Site	Site Type	Description	Volume Direction 1	Volume Direction 2	Two-way AADT	K Factor	D Factor	Truck %
189920	Telemetered	SR-93/I-75, 3.5 mi south of Turnpike, Sumter Co.	20472 N	21250 S	41722	10.1	59.84	21.66
360317	Telemetered	I-75, 0.35 mi north of Williams Rd overpass, Marion Co.	37630 N	37844 S	75474	11.14	55.41	21.76
140190	Telemetered	SR-93/I-75, 0.6 mi. south of SR 54, Pasco County	37443 N	37203 S	74646	8.76	53.67	11.71
730292	Telemetered	SR-9/I-95, 1.4 mi south of Palm Coast Pkwy, Flagler Co.	29276 N	29980 S	59256	9.91	54.92	17.82
269904	Telemetered	SR-93/I-75, 3 mi. north of Marion Co. line, Alachua Co.	31304 N	31023 S	62327	11.96	55.97	19.09
970428	Telemetered	SR-91/Fl. Turnpike, 797 ft. south of CR561, Lake Co.	17655 N	18088 S	35743	11.09	55.42	12.34

Equipment and Setup

The objective of video data collection was to depict travel along a section of rural freeway from a driver's perspective. In order to give the survey participants a more complete representation of the conditions on the freeway section, it was decided that two more video images would be captured – the vehicle's speedometer and the driver side rear-view mirror. This brought the total number of cameras needed to three. The images would be combined during the creation of the video clips.

The vehicle used for the video data collection was a minivan. As mentioned above, three cameras were placed in the vehicle in order to capture different aspects of the rural freeway trip. The first camera captured the view through the front windshield, including a view of the interior rear-view mirror. It was placed on a mount secured to the right side of the driver's seat. The second camera captured a view of the speedometer. It was mounted on a suction mount affixed to the steering column. It was found during a preliminary test that the instrument cluster needed to be shaded to reduce glare, so the image would not appear washed-out. The final camera captured a view from the vehicle's driver-side rear-view mirror. This camera was mounted on a pole secured between the driver's seat and the door. Figure 1 shows these cameras as they were mounted in the vehicle. The video images were captured by three portable VCRs placed inside the vehicle. A microphone was also connected to one of the VCRs allowing the researcher to announce when they crossed a detector loop and any other potentially important information. This would allow the researcher to match the captured video clip to the loop data collected in a later step. All these devices were powered by three 12-volt deep-cycle batteries. A schematic of the equipment and connections is found in Figure 2.

Figure 1. Camera Setup-Front View, Side View, Speedometer

Video Data Collection

The method used to capture the video clips remained constant throughout the collection of data. The researcher would activate the three VCRs and start recording. Then the researcher merged onto the freeway. The cameras captured conditions between the exit ramps that came before and after the ILD station. The researcher would speak into the microphone when the detector loop was crossed, giving the exact time and site number so the clip could be matched with the relevant loop data. Up to four runs were made at each location giving a number of clips to choose from when creating the clips for the survey. The data collection for this project was performed during November of 2003 and March 6-9, 2004. A summary of each video data collection session is shown in Table 3.

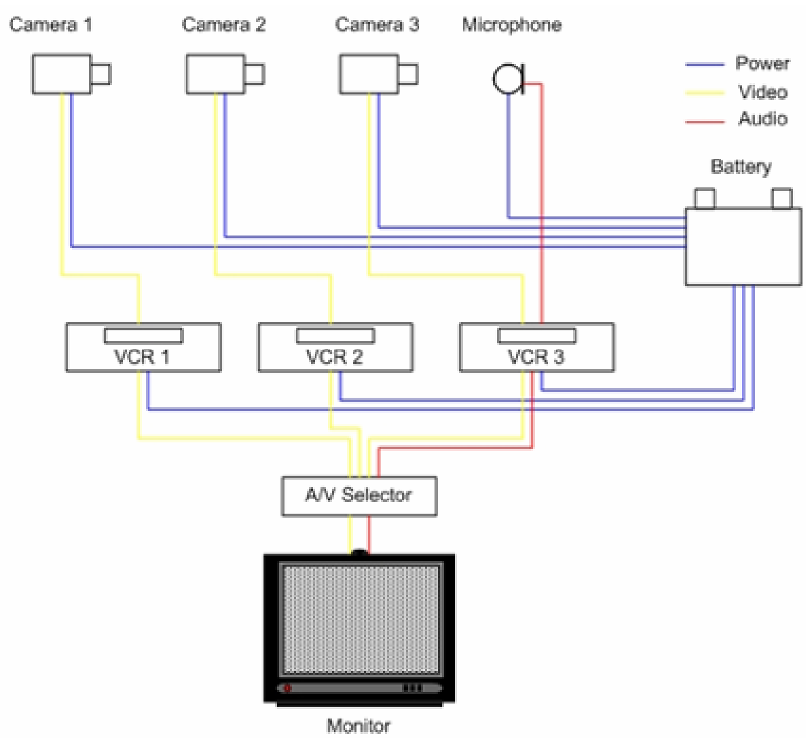

Figure 2. In-Vehicle Equipment Setup

Table 3. Data Collection Times, Locations, and Directions

Date	Site	Freeway	Direction	Time
11/4/2003	730292	I-95	NB	12:55
11/5/2003	269904	I-75	SB	11:01
11/21/2003	140190	I-75	NB	6:48
11/21/2003	140190	I-75	SB	7:04
11/21/2003	140190	I-75	SB	7:14
11/21/2003	140190	I-75	SB	2:31
3/7/2004	730292	I-95	SB	2:35
3/7/2004	730292	I-95	NB	2:47
3/8/2004	189920	I-75	SB	12:36
3/8/2004	360317	I-75	SB	11:50
3/8/2004	360317	I-75	NB	12:04
3/8/2004	360317	I-75	SB	2:07
3/8/2004	970428	Turnpike	SB	1:49

After reviewing the video data gathered on the first day of data collection, it was deemed unusable. The mounting for the camera allowed too much vibration in the picture and the video would not work for a public survey. Although the second round of video data collection was scheduled for March 6-8, the runs made on the first day needed to be redone due to problems with the camera placement, necessitating a fourth day of data collection on March 9, 2004.

Video Clip Creation

The survey participants were shown a single video display that contained the video scenes of the front windshield and interior rear-view mirror, the driver's side rear-view mirror, and the speedometer. The display used was a video projector and a wall-mounted screen, located between 5 and 20 feet away from the participants depending on the specific survey location. The setup of one of the survey sessions is depicted below in Figure 3. The majority of the screen was taken up by the view through the front windshield. Since the front windshield view captured a portion of the dashboard as well as the view from the front of the vehicle, the other two images could be overlaid on this area. A screenshot from one of the video clips used in the survey is shown in Figure 4. Screenshots from all 13 clips can be found in Appendix B.

The clips were assembled using a video-editing program (Adobe Premiere) [12]. They first had to be captured from the VHS tapes using an ADS digital encoder [13]. After they were stored on the computer hard drive they were combined using Adobe Premiere into clips from 1.5 to 2.5 minutes in length. The length of an individual clip was chosen based on events in the video that the researchers wanted to include or exclude, as well as with a survey participant's attention span in mind. The clips shown to viewers were chosen based on conditions they represented that were unique or different from other clips. This selection process is explained further in the section entitled "Video Clip Selection".

Figure 3. Setup of a Survey Session

Figure 4. Sample Video Screenshot

Inductance Loop Detector Data Collection

It was desired to calculate the LOS of these sites according the HCM methodology in order to assess how strongly correlated it was with the responses provided by the survey participants. In order to determine the HCM LOS of the rural freeway segments, data were collected from the inductance loop detector (ILD) stations at each test site. The data collected came in three files—speed, volume, and vehicle classification. FDOT personnel programmed the detectors at the sites selected for the study to record data in five-minute intervals (the hardware minimum interval) rather than the usual one-hour interval. This shorter interval allowed for traffic data that more accurately reflected the conditions depicted in the video clips. It should be noted that even with a five-minute data collection interval the conditions shown in the video clips could potentially vary from the average provided by the ILD data. These ILD data were used to categorize the collected video data and provided a starting point for selecting a range of conditions to be represented in the survey.

The ILD data were provided in the form seen in Appendix D. When available, there were three data files for each site – speed, count, and class. In the speed file, counts are provided for each speed range. The midpoints of the speed ranges are shown at the top of the table. In the class file, descriptions such as "CL01" are given to the columns. These refer to the specific class of vehicle counted in that group and are explained by the figure provided. From the data provided it was possible to calculate descriptive statistics for the traffic flow at each site, such as the percentage of heavy vehicles in the traffic stream, the total 5-minute volume, the average speed, and the density.

Video Clip Selection

There were thirteen video clips chosen for the final survey. The final number of clips chosen was a result of five pilot test sessions, striking a balance between coverage of alternatives and attention/focus span of participants. These preliminary tests had shown that many participants lost interest after two minutes and had already started writing their opinions down. The final video clips were chosen to represent a variety of conditions in categories including lane configuration, traffic density, terrain, truck percentage, the presence of a median or guardrail, and shoulder configuration. The relevant data for each video clip included in the final survey is included below in Table 4 and Table 5.

Table 4. Traffic Data for 13 Video Clips

Clip #	Road	Dir	Lanes	Clip Length	Volume[1]	Truck %[1]	Density	ILD Truck %	Inside Speed	Middle Speed	Outside Speed	LD Avg Speed	Inner Lane	Middle Lane	Outer Lane	ILD 5min Volume	Terrain	Speed
1	I-75	S	2	2:10	low	none	8.00	0.13	77.1		72.2	74.30	42		57	99	flat	75
2	I-75	S	3	1:52	med-high	high							63	75	66	204	flat	70-75
3	I-75	N	2	2:00	med-high	med	13.79	0.20	76.4		69.4	72.20	67		99	166	flat	60-70
4	I-95	N	2	1:35	very high		26.45		56.5		55.4	56.00	102		145	247	flat	40-55
5	I-75	S	3	1:40	low-med	med	6.30	0.17	77.6	74.0	66.4	72.30	26	51	37	114	rolling	70-75
6	I-95	S	2	1:59	med		10.21		76.9		74.7	75.80	63		66	129	flat	70
7	I-75	S	2	2:00	med-high	high	26.31	0.34	71.6		65.5	68.90	167		135	302	flat	67-72
8	I-75	N	3	2:01	med-high	low							61	98	80	239	flat	67-72
9	I-75	S	2	2:00	high	high	26.11	0.32	71.3		66.1	69.20	179		122	301	flat	55-65
10	I-95	N	2	1:43	med		10.86		78.4		69.4	72.90	80		52	132	flat	75
11	I-75	S	3	1:26	med	med							48	82	48	178	flat	70-75
12	I-75	S	2	1:27	med-high	med	17.04	0.15	73.6		68.2	71.10	110		92	202	flat	60-65
13	Turnpike	S	2	2:03	med	high											rolling	75-80

[1] These levels (low, med, high) indicate subjective judgments that were used to choose between clips.

Table 5. Clip Sites, Dates, and Times

Clip #	Clip	Site	Time	Date	Closest City
1	189920 run 1	189920	12:36	3/8/2004	Wildwood
2	360317 run 1	360317	11:50	3/8/2004	Ocala
3	Tampa 0648	140190	6:48	11/21/2003	Tampa
4	730292 run 4	730292	14:47	3/7/2004	Daytona Beach
5	Micanopy 1101	269904	11:01	11/5/2003	Micanopy
6	730292 run 3	730292	14:35	3/7/2004	Daytona Beach
7	Tampa 0714	140190	7:14	11/21/2003	Tampa
8	360317 run 2	360317	12:04	3/8/2004	Ocala
9	Tampa 0704	140190	7:04	11/21/2003	Tampa
10	Daytona 1255	730292	12:55	11/4/2003	Daytona Beach
11	360317 run 3	360317	12:07	3/8/2004	Ocala
12	Tampa 1431	140190	14:31	11/21/2003	Tampa
13	970428 run 1	970428	13:49	3/8/2004	Winter Garden

Survey Sessions

Development of Survey Form and Participant Instructions

The survey form for this study had to serve two purposes—record the participants' opinions about the rural freeway video clips and their reasons for these opinions, and record characteristics about the participants that might influence their ratings. Thus the form is divided into two sections.

The first section of the survey form is for personal information about the traveler taking the survey. Examples of this information include education level, income, and number of years possessing a driver's license. This section also records information about the participant's rural freeway travel habits. It asks for information such as the amount of rural freeway trips taken per month and the average length of the participant's rural freeway trips. Finally it asks for some driving habits, such as any changes in the participant's driving style when driving alone versus with a passenger. It also asks the participant to rate their usual driving style, from Conservative to Aggressive.

The second section of the survey is for recording the participant's opinions and rankings of the video clips. It is divided into two sections for each of the thirteen clips. The first section asks the participant to rank the quality of the trip depicted in the video clip on a scale from 'Very Poor' to 'Excellent' with 6 total ranking levels. A total of six ranking levels was chosen so that there would be general correspondence with the six levels of the HCM (A-F). Participants were asked to use the word ranking rather than a numerical ranking (e.g., 1-6) to minimize the possibility that those familiar with the HCM might try to equate the numerical rankings with the HCM LOS rankings. The second section asks the participant to record why they ranked the video clip as they did, listing all factors that significantly contributed to their ranking. The participants were to then number these according to their relative significance to each other.

Finally the form includes questions about the survey itself. These include the participant's opinion on the video clips as a representation of rural freeway travel and if the participant would have changed their rankings based on the purpose of the trip (e.g., business, recreational, or social).

A one page written survey instruction sheet was developed because there was a significant amount of information that needed to be communicated to the participants in order for them to complete the survey form in a manner which would be useful as study data. The participants could refer back to it if there were any questions about the survey process. The instructions given to each survey participant are provided in Appendix C.

Conducting the Survey Sessions

Survey participants were recruited from various sources. They include the following:

- Undergraduate students in the University of Florida civil engineering program, recruited from the introductory transportation engineering course,
- Graduate students in the University of Florida civil engineering program, recruited from the transportation degree program,
- Employees of the University of Florida Technology Transfer Center,
- Employees of the Florida Department of Transportation, and
- Alachua county residents (Random participants recruited for a fee by the Florida Survey Research Center)

The undergraduate students were recruited from the Principles of Highway Engineering and Traffic Analysis course during the Fall 2004 semester. The graduate students were those enrolled in a transportation engineering degree program during the Fall 2004 semester. The University of Florida Technology Transfer Center is an organization that provides training and technical assistance to Florida's transportation and public works professionals. Their survey session was conducted at their off-site headquarters in Gainesville, FL, with participants ranging from high-school educated support staff to professionals with graduate degrees. The FDOT survey session was conducted at the central office in Tallahassee, FL. This session also included participants of varying backgrounds and demographics. The public sample was comprised of Alachua county residents, recruited by the University of Florida Survey Research Center. The survey center was instructed to recruit individuals with varying socio-demographic characteristics and also make sure that the participants had experience driving on rural freeways. Additionally, they did not recruit college students as there was already a sufficient number in this group.

In total there were 126 surveys filled out for this study. The locations, dates, and groups of participants taking the survey during each session are given in Table 6.

Table 6. Dates and Locations of Survey Sessions

Survey Session	Date	City	Location	Participants	# of Surveys
1	8/4/04	Gainesville	UF Technology Transfer Center	T^2 employees	16
2	11/16/04	Tallahassee	Florida DOT Central Office	DOT employees	11
3	12/2/04	Gainesville	University of Florida	undergraduate students	14
4	12/2/04	Gainesville	University of Florida	undergraduate students	9
5	12/4/04	Gainesville	UF Hilton Conference Center	public[1]	13
6	12/4/04	Gainesville	UF Hilton Conference Center	public[1]	15
7	12/4/04	Gainesville	UF Hilton Conference Center	public[1]	11
8	12/9/04	Gainesville	University of Florida	undergraduate students	20
9	1/22/05	Gainesville	University of Florida	public[1]	9
10	1/27/05	Gainesville	University of Florida	graduate students	8
			Total Number of Surveys		**126**

[1]Participants were recruited through the University of Florida Survey Research Center

Because of the video format of the survey, multiple surveys could be filled out at a time, the main limitations being the ability of the participants to comfortably view the video screen and the length of time for which the participants could be expected to focus on this task. The screen was placed as close as possible to eye level so participants looking at the screen saw it as they would a car’s windshield. Before viewing the clips the participants were given the instruction sheet and time to read it. These written instructions were also verbally reviewed by the session moderator, as well as some supplemental information. The participants were also told that they could ask interpretation questions in-between the viewing of the video clips. It was decided to create two example clips, each 20 seconds long, to show the upper and lower ends of the range of possible traffic flows. The first was a nearly empty four-lane freeway and the second was stop-and-go traffic along a four-lane freeway. The participants were then shown each of the 13 video clips and instructed to watch each clip entirely before writing their responses. Since it was not intended for the order of the clips to have any effect on the participants' rankings, the order was shifted for each survey session. After each clip was finished, the participants were given time to record their rankings.

CHAPTER 4
ANALYSIS AND RESULTS

This chapter contains information about the methodology used to analyze the survey data, as well as the results of these analyses.

Analysis Method

To determine how or if the participants' responses correspond to the six LOS rankings, a statistical analysis was needed to predict the probability of selecting discrete rankings (1-6 as included in the survey). While one of several multinomial discrete-choice modeling methods would suffice to predict a discrete outcome, most do not take into account the ordered nature of the responses in this survey (1 is better than 2, which is better than 3, etc.). Using a standard multinomial discrete model, such as a multinomial logit model, would still yield consistent parameter estimates, but with a loss of efficiency [14]. In order to account for the discrete and ordered responses in this survey, an ordered probability model was chosen as the statistical analysis approach.

An ordered probability model is derived by defining an unobserved variable, z, that is the basis for modeling the ordinal ranking of data (in this case the six clip rankings) [15]. This variable is specified as a linear function for each observation n such that

$$z_n = \boldsymbol{\beta X_n} + \varepsilon_n \tag{1}$$

where $\boldsymbol{X_n}$ is a vector of variables determining the discrete ordering for observation n, $\boldsymbol{\beta}$ is a vector of estimable parameters, and ε_n is a random disturbance. In this analysis, y is defined as each participant's evaluation of each of the 13 video clips. Since there are 126 participants and 13 clips, there are a total of 1638 observations. Using this equation, the observed clip ranking, y_n for each observation is written as

$$
\begin{aligned}
&y_n = 1 \text{ if } z_n \leq \mu_1 \\
&y_n = 2 \text{ if } \mu_1 < z_n \leq \mu_2 \\
&y_n = 3 \text{ if } \mu_2 < z_n \leq \mu_3 \\
&y_n = 4 \text{ if } \mu_3 < z_n \leq \mu_4 \\
&y_n = 5 \text{ if } \mu_4 < z_n \leq \mu_5 \\
&y_n = 6 \text{ if } z_n \geq \mu_5
\end{aligned} \tag{2}
$$

where the μ values are the thresholds that define y_n. The μ values are estimated jointly with the model parameters ($\boldsymbol{\beta}$). The estimation problem then becomes one of determining the probability that a participant will select a particular ranking for each clip. In using the ordered probit model, it is assumed that the error term, ε_n, is normally distributed with a mean of 0 and a variance of 1. The resulting ordered probit model has the following probabilities corresponding to each clip ranking:

$$
\begin{aligned}
&P(y_n = 1) = \boldsymbol{\Phi}(-\boldsymbol{\beta X_n}) \\
&P(y_n = 2) = \boldsymbol{\Phi}(\mu_1 - \boldsymbol{\beta X_n}) - \boldsymbol{\Phi}(-\boldsymbol{\beta X_n}) \\
&P(y_n = 3) = \boldsymbol{\Phi}(\mu_2 - \boldsymbol{\beta X_n}) - \boldsymbol{\Phi}(\mu_1 - \boldsymbol{\beta X_n})
\end{aligned} \tag{3}
$$

$$P(y_n = 4) = \boldsymbol{\Phi}(\mu_3 - \boldsymbol{\beta X_n}) - \boldsymbol{\Phi}(\mu_2 - \boldsymbol{\beta X_n})$$

$$P(y_n = 5) = \boldsymbol{\Phi}(\mu_4 - \boldsymbol{\beta X_n}) - \boldsymbol{\Phi}(\mu_3 - \boldsymbol{\beta X_n})$$

$$P(y_n = 6) = 1 - \boldsymbol{\Phi}(\mu_4 - \boldsymbol{\beta X_n})$$

It can be shown that threshold μ_1 can be set equal to 0 without loss of generality [15]. In the above equations, $\boldsymbol{\Phi}(.)$ represents the cumulative normal distribution:

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-\frac{1}{2}w^2} dw \tag{4}$$

This model can be estimated using maximum likelihood procedures.

The thresholds μ_1 and μ_1 define the upper and lower thresholds for outcome *i*. This is illustrated in Figure 5.

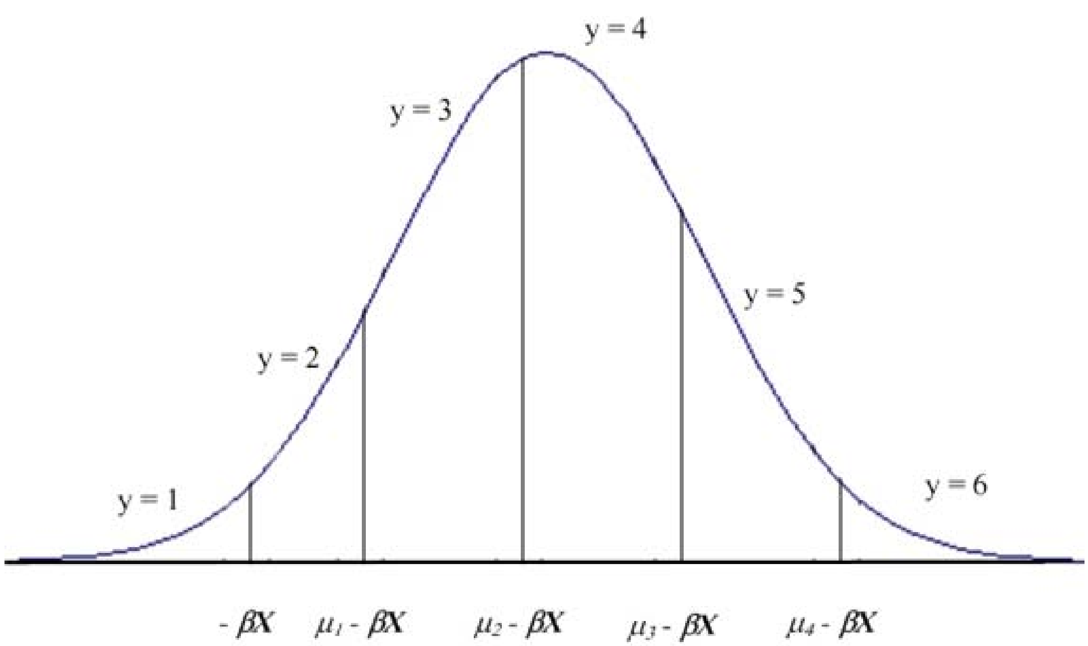

Figure 5. Illustration of an Ordered Probability Model

A positive increase in the $\boldsymbol{\beta}$ term implies that an increase in x will increase the probability that the highest category response will be returned (in this case, $y = 6$). An increase in the

$\boldsymbol{\beta}$ term also implies that the probability of returning the lowest response (y = 1) is decreased. This is illustrated in Figure 6.

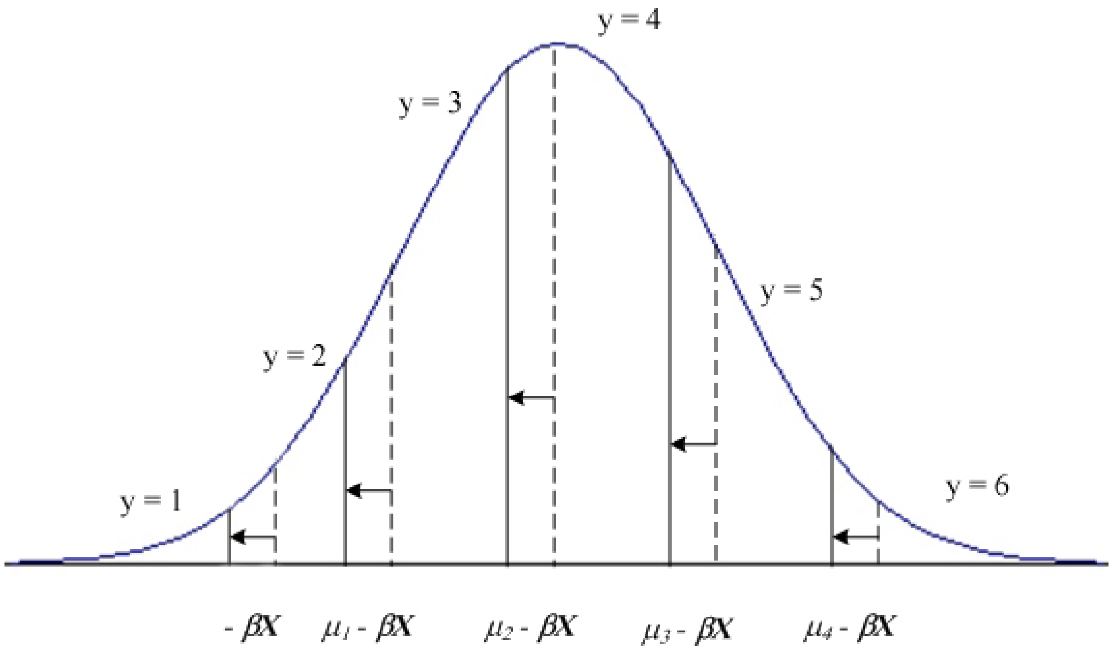

Figure 6. Illustration of an Ordered Probability Model with an Increase in $\boldsymbol{\beta}$

A unique issue was present in this data set that complicated the analysis procedure. Each of the 126 participants viewed 13 clips and thus generated 13 observations. The issue is that there are unobserved characteristics that are unique to each participant that will be reflected in all 13 of their rankings. If this is not accounted for in the model, the model will be estimated as though each of the 1638 observations came from a unique participant. This approach would result in lower standard errors in the model's estimated parameters, leading to inflated *t*-statistics and exaggerated degrees of significance.

The solution to this problem is found in a standard random effects approach. The first equation is rewritten as

$$z_{ic} = \boldsymbol{\beta X_{ic}} + \varepsilon_{ic} + \varphi_i \quad (5)$$

where i denotes each participant (i = 1,…,126), the c denotes each video clip (c = 1,…,13), φ_i is the individual random effect term and all other terms are as previously defined. The random effect term φ_i is assumed to be normally distributed with mean 0 and variance σ^2. When this random effects model is estimated, an estimate of σ is also calculated, the significance of which determines the significance of the random effects model relative to the standard ordered probit model [16].

Statistical Analysis

The results of the surveys were put into spreadsheet form, with unique cases for each clip viewing. Each participant's rankings were kept together within the spreadsheet for analysis purposes. The data were analyzed using LIMDEP [17] with a random effects approach as detailed in the previous section.

The first analysis was performed to explore how the quality of service perceptions of the participants in this survey correlated with the HCM LOS thresholds. The density for each of the video clips was calculated from the loop detector data (and the video data, in cases where the loop detector data was incomplete). A statistical analysis was performed using density as the only independent variable to find out where the thresholds of the survey participants fell relative to the six clip rankings. The results are given below in Table 7.

The very high level of significance indicated by the t-statistic (coefficient divided by standard error) calculated for density in the above model offers some evidence that this performance measure correlates well with perceived LOS. The reference *t*-statistic for these analyses is 1.282, representing a 90% confidence level in a one-tailed *t*-test. The positive coefficient calculated for density indicates that, as density increases, the likelihood of a traveler perceiving a worse LOS increases. The random effects term, σ, is also highly significant, meaning that the choice of a random effects model for this data set was correct. Had this term not been significant, a normal ordered probability model would have been sufficient.

One test for the goodness-of-fit of a model is calculating that model's ρ^2 value. The ρ^2 value of a model is between 0 and 1. A ρ^2 value of 1.0 indicates a perfect model fit. The ρ^2 value of a model is calculated as follows:

$$\rho^2 = 1 - \frac{LL(\beta) - K}{LL(0)} \tag{6}$$

where K represents the number of variables in the model, $LL(\beta)$ represents the log likelihood at convergence, and $LL(0)$ represents the initial log likelihood [15].

Table 7. Density Model Estimation Results

Variable	**Coefficient**	**Standard Error**	***t*-statistic**
Constant	-0.138	0.076	-1.82
Traffic Characteristics			
Density (pc/mi/ln)	0.096	0.003	34.37
Threshold Values			
μ_1	0.918	0.038	23.89
μ_2	1.922	0.048	39.92
μ_3	2.863	0.053	53.88
μ_4	4.112	0.066	62.47
Standard Deviation of Random Effects			
σ	0.455	0.050	9.12
Initial Log Likelihood			-2710.16
Log Likelihood at Convergence			-2314.60
ρ^2			0.15

Using the participants' responses it was possible to calculate a set of thresholds for the participants' assigned LOS rankings. Using the calculated values in Table 7, the threshold values can be calculated as $(\mu_k - \beta_0)/\beta_1$. In this equation, k designates the five threshold values, $\mu_1 = 0$, and the other threshold values are given in Table 7. A comparison between the calculated threshold values from this survey and the HCM LOS thresholds is given in Table 8.

Table 8. Comparison of Estimated and HCM LOS Thresholds

LOS	**Estimated Thresholds (pc/mi/ln)**	**HCM thresholds (pc/mi/ln)**
A	0-2	0-11
B	>2-11	>11-18
C	>11-21	>18-26
D	>21-31	>26-35
E	>31-44	>35-45
F	>44	>45

These thresholds are generally lower than the HCM thresholds for corresponding rankings, indicating the participants in this survey had a lower tolerance for high-density traffic conditions than could be inferred from the HCM LOS thresholds.

The second analysis that was performed was intended to take into account all the traffic and roadway characteristics influencing the participants' perception of trip quality. The results of this table are given below in Table 9.

The traffic characteristics examined produced effects according to expectations. The calculated difference in speed between the inner lane and the outer lane was in the model as "speed differential". As this value increased, participants were more likely to assign a worse LOS to a given set of conditions. A higher average speed resulted in a more favorable LOS ranking. Motorists in this survey found three lanes in one direction to be a preferred configuration over two lanes and were more likely to assign a favorable LOS ranking to those roadways with three lanes in one direction.

Table 9. Traffic Characteristics Model Estimation Results

Variable	**Coefficient**	**Standard Error**	**t-statistic**
Constant	6.296	0.597	10.55
Traffic Characteristics			
Speed Differential (mi/h)	0.163	0.027	6.08
Average Speed (mi/h)	-0.096	0.009	-10.97
3 Lanes (1 - Yes, 0 - No)	-1.848	0.210	-8.82
Truck %	0.005	0.004	1.04
Density (pc/mi/ln)	0.061	0.006	10.59
Threshold Values			
μ_1	0.949	0.064	14.88
μ_2	2.192	0.077	28.48
μ_3	3.258	0.092	35.60
μ_4	4.630	0.106	43.80
Standard Deviation of Random Effects			
σ	0.522	0.060	8.76
Initial Log Likelihood			-2710.16
Log Likelihood at Convergence			-1472.53
ρ^2			0.45

An increase in the truck percentage resulted in a higher possibility of a worse LOS ranking. While the t-statistic for the truck percentage was below 1.282, it was decided to leave this variable in the model because it was felt that this was a very important variable from a policy standpoint. As expected, the participants preferred not to have a high percentage of trucks in the traffic stream. Finally, density was very significant in this model as it was in the first. A higher density led to an increased possibility of a worse LOS ranking. The random-effects term was again significant in this analysis, justifying the use of a random-effects model.

The third analysis that was performed was aimed at discovering which factors are important to travelers when judging their trip quality. This model was estimated including demographic data as well as roadway and traffic flow characteristics. The values given in Table 10 should be interpreted such that a positive parameter estimate means that an increase in that variable will lead to a better perceived quality of service, and a negative parameter estimate means that an increase in that variable will lead to a worse perceived quality of service.

Table 10. Level of Service Model Estimation Results

Variable	**Coefficient**	**Standard Error**	**t-statistic**
Constant	6.156	0.622	9.90
Demographic and Background Information			
Age > 35 (1 - Yes, 0 - No)	-0.358	0.121	-2.96
Income (thousands of $)	-0.003	0.002	-1.89
Average Number of Rural Freeway Trips per Month	0.025	0.017	1.49
Average One-Way Trip Distance > 100 miles? (1 - Yes, 0 - No)	0.395	0.127	3.11
Less Aggressive Driver with Passengers? (1 - Yes, 0 - No)	0.267	0.186	1.43
Traffic Characteristics			
Speed Differential (mi/h)	0.162	0.028	5.85
Average Speed (mi/h)	-0.095	0.009	-10.58
3 Lanes (1 - Yes, 0 - No)	-1.836	0.217	-8.47
Truck %	0.005	0.005	1.03
Density (pc/mi/ln)	0.062	0.006	10.56
Threshold Values			
μ_1	0.939	0.065	14.56
μ_2	2.181	0.078	27.93
μ_3	3.247	0.093	34.90
μ_4	4.613	0.107	43.21
Standard Deviation of Random Effects			
σ	0.435	0.059	7.42
Initial Log Likelihood			-2710.16
Log Likelihood at Convergence			-1447.34
ρ^2			0.46

In Table 10, a positive coefficient value indicates that as the variable increases, there is an increased likelihood of a worse perception of LOS. Likewise, a negative coefficient value indicates that as the variable increases, there is an increased likelihood of a better perception of LOS.

The results indicate that, while density is important to travelers, it is not the only factor influencing perceived quality of service. The survey results showed significant effects of demographic and background information on drivers' LOS rankings. Table 10 indicates that participants with over 35 are more likely to assign a given set of conditions a better LOS, as are those with higher incomes.

Travelers who drive on rural freeways more frequently are more likely to perceive a worse LOS, as are those whose average rural freeway trip is over 100 miles in one-way length. Those participants who indicated that they tend to drive less aggressively with passengers in the car as opposed to driving alone were more likely to assign a worse LOS to a given set of conditions. A possible explanation is that these drivers are more aggressive than the average motorist. Participants were asked if they considered themselves to be an aggressive driver, and the results of that model did not display significance. Perhaps motorists were more reluctant to admit they drive aggressively, but this tendency manifests itself in their responses to this question.

The results estimated using the traffic and roadway characteristic variables showed similar significance and magnitude to the model estimated only using these variables. The random effects term was once again significant.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

Since 1963, the Level of Service concept has been integral to the Highway Capacity Manual methodology for assessing the performance of transportation facilities. There is, however, still relatively little known about how the HCM methodologies for assigning LOS correspond to road users' perceptions of their quality of service. The purpose of this study was to investigate what factors influenced road users' perceptions of quality of service, and how that perception compares to HCM calculated LOS.

Data Collection and Video Clip Creation

The data collection process used for this study proved successful in gathering the necessary video data. After deciding on the best camera positions and mounting techniques, all cameras recorded clear, steady views of their intended targets. The equipment in the vehicle performed exactly as intended, capturing the necessary information while keeping all three VCR timers consistent so the video data could be synchronized at a later time.

The sites chosen generally provided a good variety of traffic conditions, but some clips from a pilot study were also used to provide additional roadway and traffic conditions that were not captured in the data collection effort for this project. These clips were re-edited using the same process as the clips filmed for this study so there would be consistency in the screen views.

The loop detector data did not work out as well for some of the sites as was initially hoped. Due to malfunctioning detectors or construction at the selected sites, some of the desired data were not available.

The final form of the video clips and the presentation to survey participants worked very well, exactly as intended. The last question on the survey form (as seen in Appendix A) asked participants to rate how well the video clips simulated the driving experience for the conditions depicted on the screen. The majority of participants found the survey to be a “very good” representation of the actual driving experience, with 95% of the participants rating the survey as a “good” or better representation of the actual driving experience. The responses to this question are tabulated in Table 11. As shown in this table, the average response from participants was approximately a 2 out of 6, corresponding to “very good”.

Table 11. Realism of Video Survey Responses

Ranking	**Excellent** 1	**Very Good** 2	**Good** 3	**Fair** 4	**Poor** 5	**Very Poor** 6
Frequency	21	64	36	5	1	0
Percent of Total Responses (%)	17	50	28	4	1	0
Average Rank	**2.2**					

Statistical Analysis

The analysis process chosen for this survey was an ordered probability model, specifically the ordered probit model. The structure of the standard ordered probit model formulation does not account for each participant providing 13 responses, so a random-effects formulation was used. This modeling choice was justified, with the standard deviation of random effects showing significance in all statistical analyses.

The first model developed was one incorporating only density as an independent variable. This produced results that were as expected, that density is very significant to travelers when they are judging the quality of service provided by a rural freeway.

A complimentary outcome of this analysis was that density thresholds for each LOS were estimated according to the survey participants' responses. For LOS A-E, the survey participants showed a lower tolerance for high-density traffic conditions, hence their estimated thresholds were lower. The HCM thresholds and the estimated thresholds showed similar values for LOS F.

The second model was estimated to include the influence of other roadway and traffic characteristics. The results of this model showed that while density is significant to user perception of LOS, there are other significant factors influencing this perception, such as average speed of the traffic stream and the speed differential between lanes.

The final model included all factors from the survey that were found to be significant, including demographic factors as well as roadway and traffic characteristics. The results of this model indicated that the background and characteristics of the individual road user can influence their perception of LOS. While this result was expected, it is still significant due to the implications for a potential future modification to the HCM LOS methodology.

Study Limitations and Recommendations for Further Research

Since the scope of this study was limited to North Central Florida, additional testing with participants from a variety of other geographic regions would be needed to adopt any findings on a national level. An expanded sample, both geographically and in roadway conditions, would provide much more comprehensive coverage of the roadway and traffic condition combinations. The video survey format has inherent limitations as well. In a future study, it would be desirable to allow road users to drive in a traffic stream with known characteristics (density, truck percentage, etc.), then express their opinion regarding the LOS of the roadway section. This was not considered for this study due to cost and liability. The results of this survey could be compared to the results of the video survey to assess the accuracy of the video survey. If the video survey is shown to be an accurate method of simulating traffic conditions, it can be used in future studies and will be more effective than in-field surveys. Finally, although participants were told to imagine the conditions in the video scenes as if they were occurring throughout the duration of a trip, it is not known whether actually experiencing these conditions for an equivalent time to an entire trip would change the outcome.

It is hoped that the findings of this study will lead to further developments in this area. The study does show that density is significant in determining a road user's perception of trip quality. It is also known that there are significant factors influencing LOS other than density and these should be explored more completely. Ultimately, a better understanding of travelers' perceptions of quality of service will lead to a better use of the available resources to improve the roadway network where it is really needed, and to more accurate planning and accommodating for future demands.

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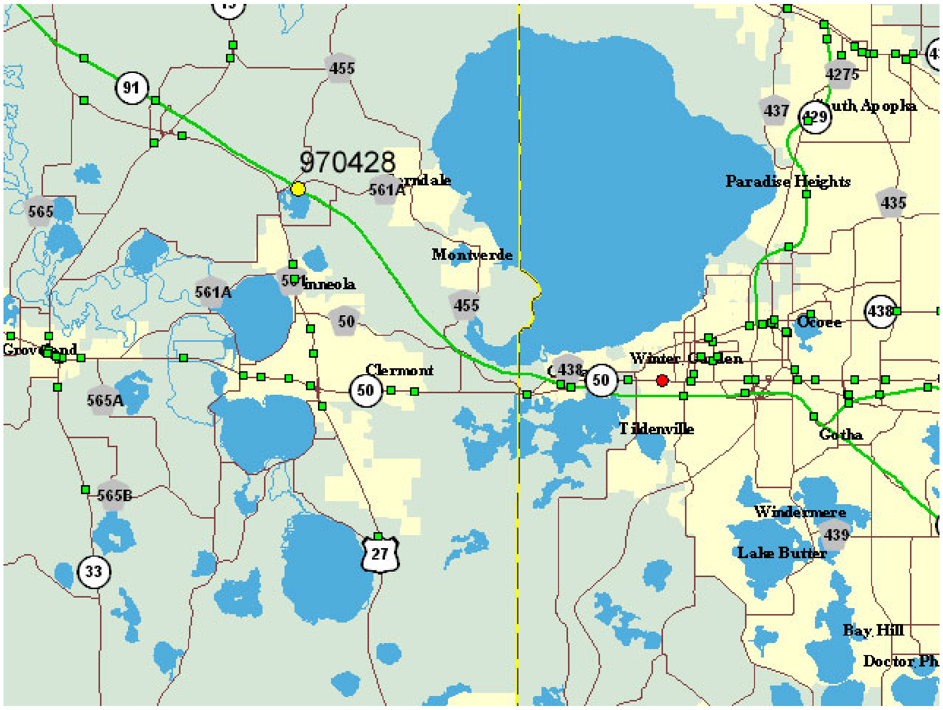
APPENDIX A
LOCATIONS OF DATA COLLECTION SITES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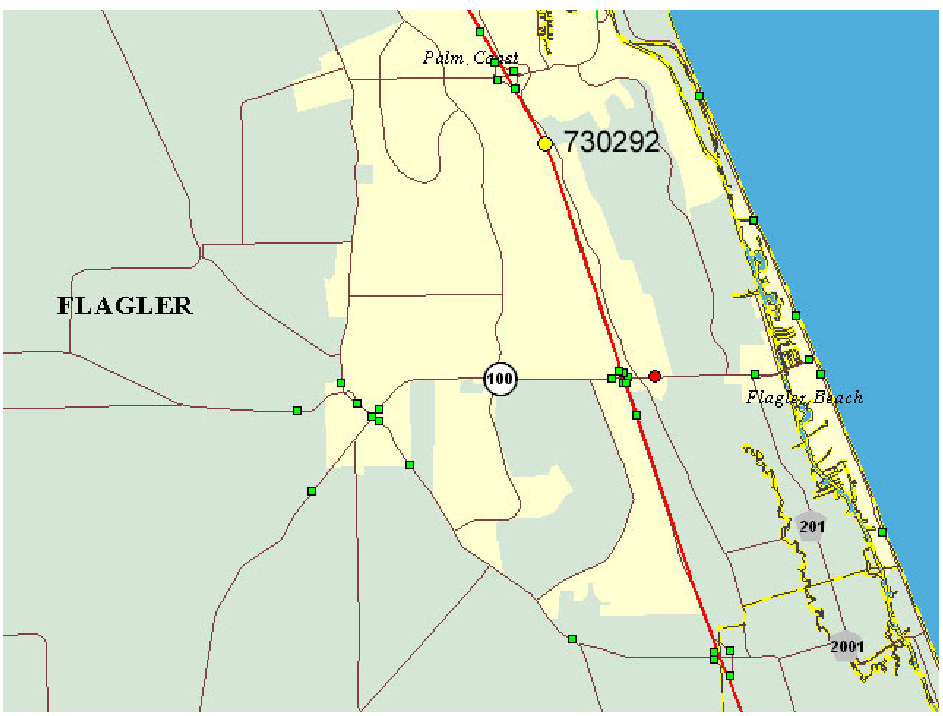
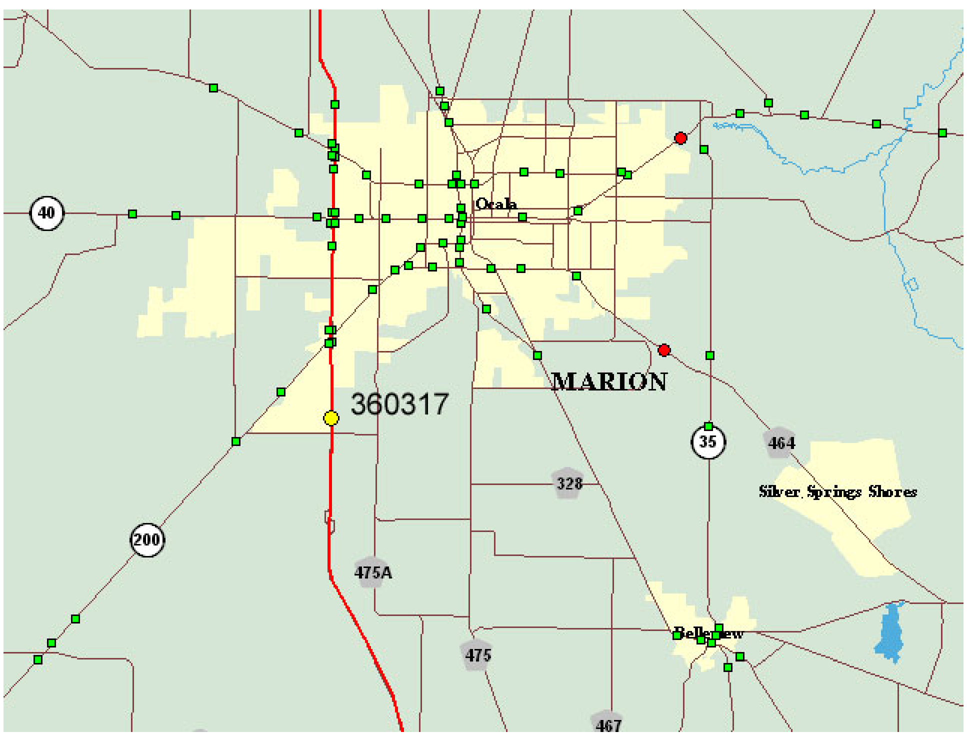
91
455
561A
565
Montverde
561A
50
455
Clermont
50
565A
565B
27
33
4275
437
429
Paradise Heights
435
438
Ocoee
Winter Garden
Tildenville
Gotha
Windermere
439
Lake Butler
Bay Hill


730292
FLAGLER
100
Flagler Beach
201
2001


140190
54
581
Land O' Lakes
579
Wesley Chapel
597
Pebble Creek
Cheval
Lutz
41
HILLSBOROUGH
75
579
597
581
301
Lake Magdalene
University
582A
582
Greater Carrollwood
Thonotosassa
Temple Terrace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Ocala
MARION
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Silver Springs Shores
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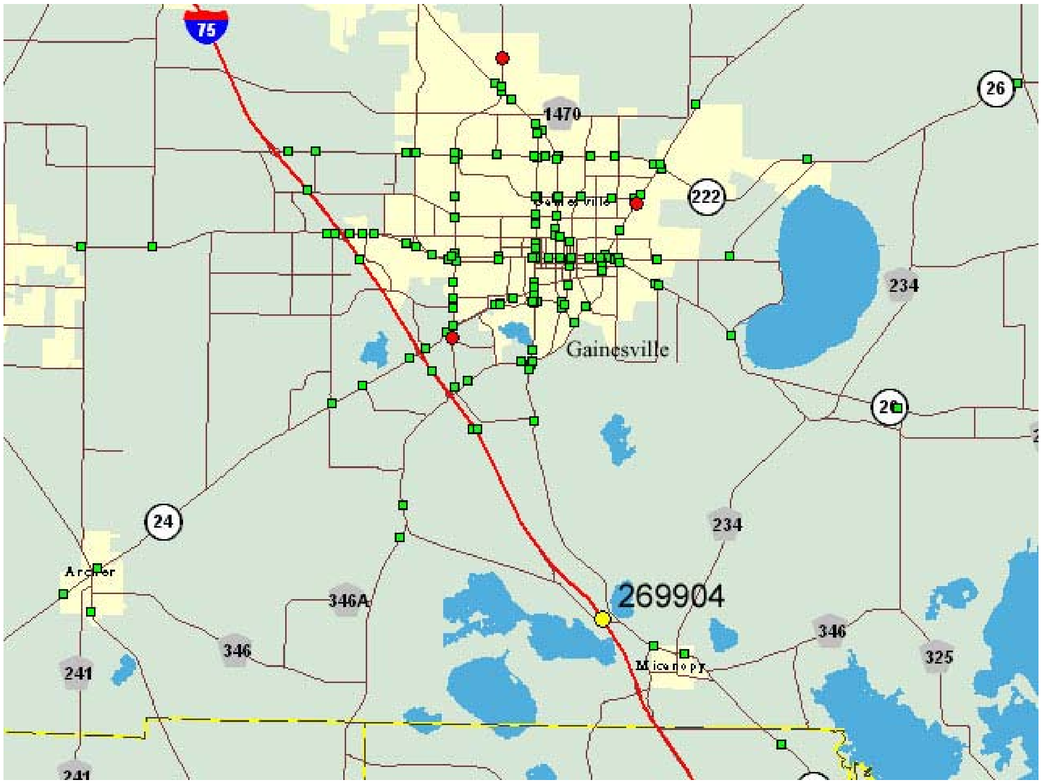
Belleview
475
467


75
1470
26
222
234
Gainesville
24
234
269904
346A
346
325
241
346
Archer
Micanopy

APPENDIX B
VIDEO CLIP SCREENSHOTS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50
60
70
80
90
100
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km/h


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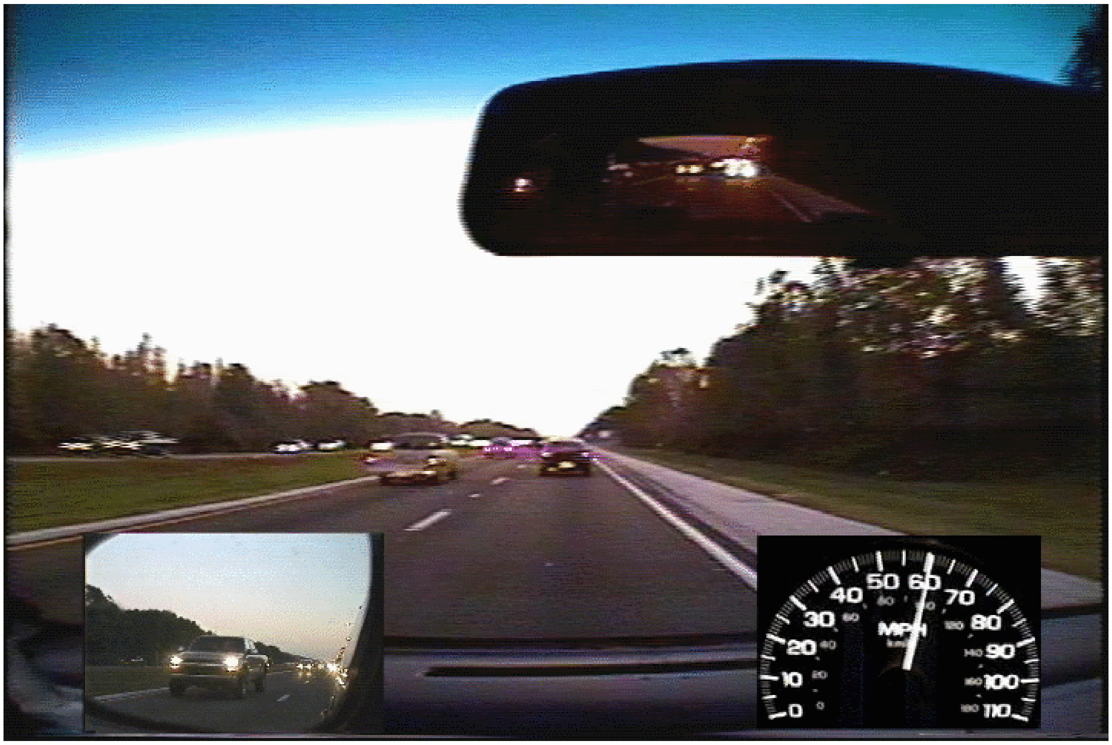
km/h


0 10 20 30 40 50 60 70 80 90 100 110
MPH


0 10 20 30 40 50 60 70 80 90 100 110
MPH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MPH


0 10 20 30 40 50 60 70 80 90 100 110
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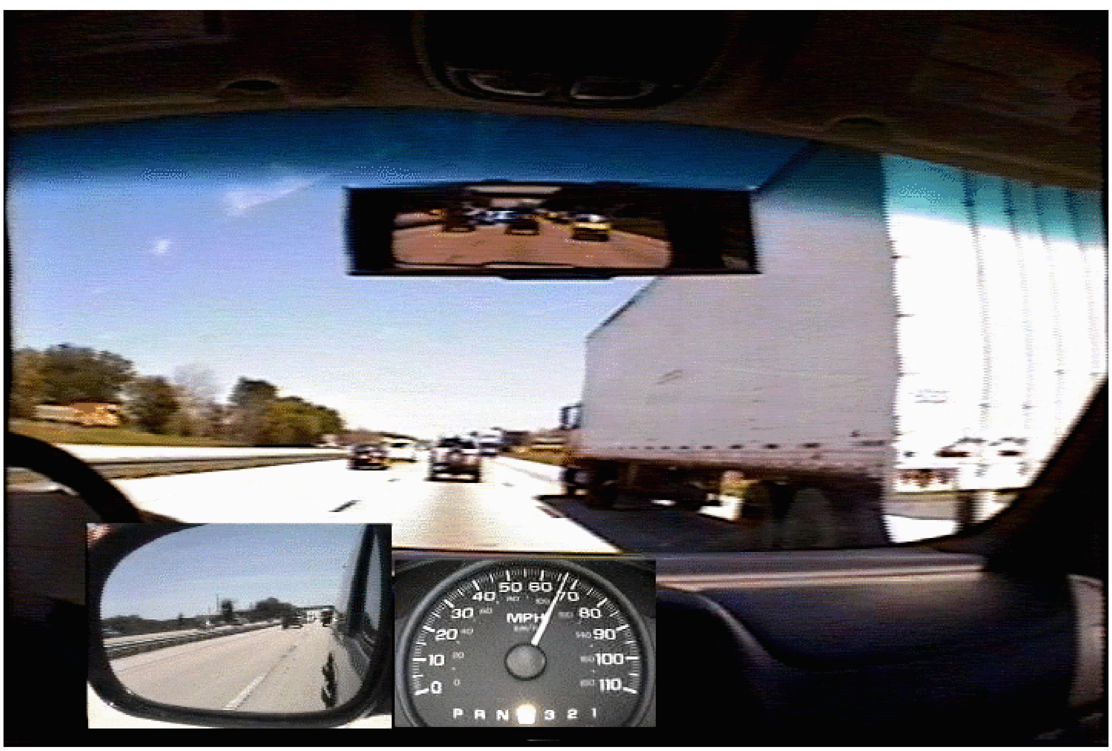
MPH
0 10 20 30 40 50 60 70 80 90 100 110


MPH
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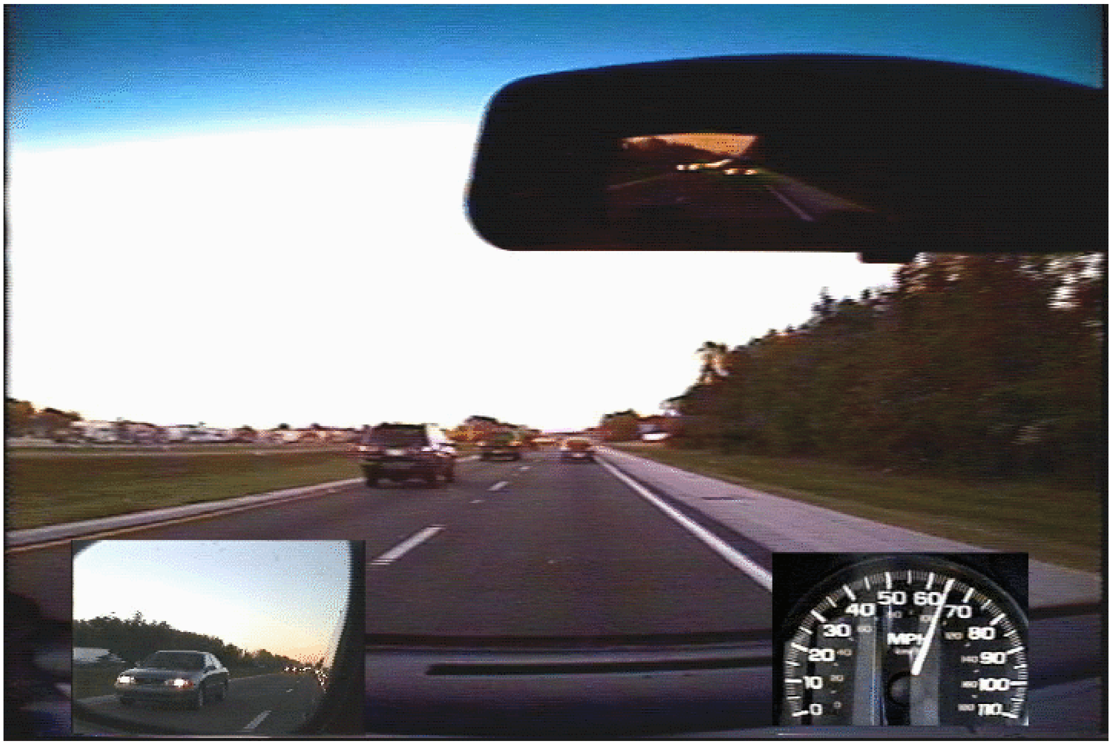
P R N 3 2 1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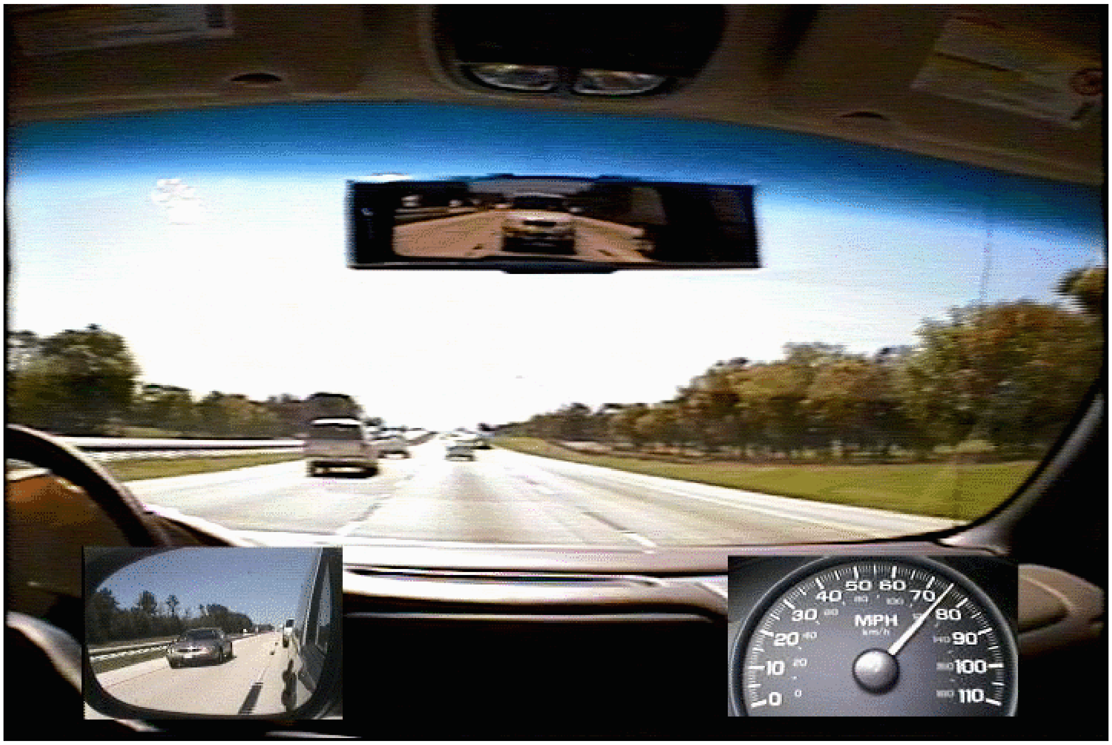
MPH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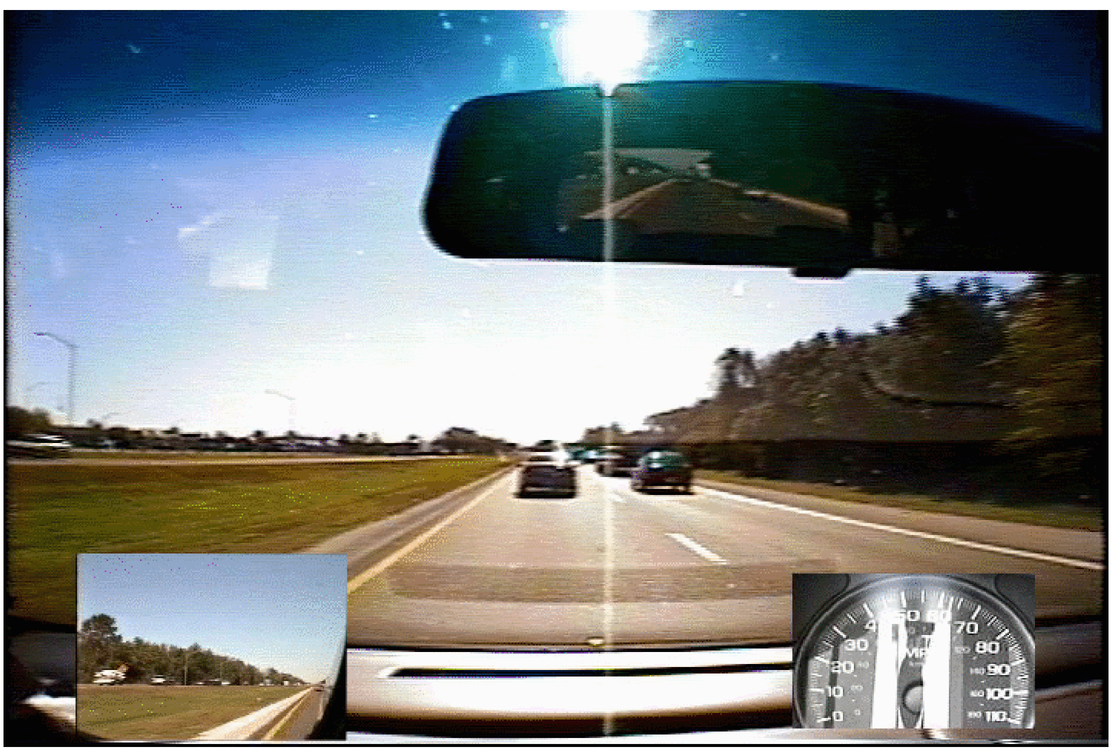
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MPH
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APPENDIX C
RURAL FREEWAY TRIP QUALITY SURVEY FORM

UNIVERSITY OF FLORIDA

RC

Transportation Research Center

Rural Freeway Trip Quality Survey

In the exercise you are about to participate in, you will be watching a series of 13 short video segments of various roadway and traffic conditions on rural freeways. A rural freeway is a freeway that travels through relatively unpopulated areas. Rural freeways are typically used for longer trips, such as city-to-city trips. All freeway segments (whether in urban, rural, or other types of areas) are characterized by opposing directions of traffic being separated by either a physical barrier or open space. All freeways are also characterized by limited access, that is, entry to and exit from a freeway can only be made at interchanges (on- and off-ramps). For rural freeways, interchanges are spaced much further apart than along freeways in urban areas.

Each of the video clips is approximately 1.5 to 2 minutes in length. Each clip is intended to give you a "snapshot" of the typical conditions experienced over the course of an extended trip on a rural freeway. When watching each video clip, please imagine and/or keep the following points in mind:

- The conditions viewed on the video clip for about 2 minutes are intended to be representative of what you would experience for a much longer trip (30 minutes or more).
- Imagine how you would personally drive, or try to drive, in the given conditions. You are not limited to the driving behavior of the vehicle from which the video is being viewed. The intent of the video vehicle is to provide you with a reasonable representation of the typical conditions being experienced by ALL motorists on that section of rural freeway. Therefore, your survey responses should not be specific to how the video vehicle was being driven. If you feel like you would, and could, drive differently under the given conditions, then base your survey responses on that. It is important that your survey responses reflect how the given conditions affect your perception of trip quality based upon your own desired driving behavior.

After watching each video clip, we ask that you do the following on the survey form:

- Rank (from Very Poor to Excellent) the travel conditions
- In the space provided, briefly list the reasons/factors for why you ranked the conditions in that video clip as you did. Please be as specific as possible—for example, you might say 'opportunities to pass other vehicles in order to maintain my desired speed were limited', as opposed to 'speed was too low'.

The video clips are intended to be weather neutral—that is, in developing the video clips it was not our intent to have weather be a significant factor in your trip quality perceptions. Although the lighting conditions may vary somewhat, please do not factor in the environmental conditions unless you feel very strongly about a certain condition.

If you recognize the freeway section, disregard previous knowledge and experience and base your ranking strictly upon the conditions observed in the video clip.

Thank you for your cooperation and participation.

UNIVERSITY OF FLORIDA

TRC
Transportation Research Center

About Yourself

Gender: ☐ Male ☐ Female

Age: ☐ 16 to 25 years ☐ 26 to 45 years ☐ 46 to 65 years ☐ Over 65 years

Marital Status: ☐ Single ☐ Married ☐ Separated/Divorced ☐ Widowed

Highest level of education:

☐ Some or no high school ☐ High school diploma or equivalent
☐ Technical college degree (A.A.) ☐ College degree ☐ Post-graduate degree

Approximate annual household income:

☐ No income ☐ Under $25,000 ☐ $25,000 – 49,999 ☐ $50,000 – 74,999
☐ $75,000 – 99,999 ☐ $100,000 – 149,999 ☐ $150,000 or more

Number of years possessing a driver's license: _________

About Your Rural Freeway Driving

Typical number of rural freeway round trips made during a month?

☐ 1 to 2 ☐ 3 to 4 ☐ 5 to 6 ☐ 7 to 8 ☐ 9 to 10 ☐ 11 to 12 ☐ Over 12

Typical percentage of these trips made as a driver ______, as a passenger ______ (should sum to 100)

Typical one-way length of trip made on a rural freeway (in miles)?

☐ less than 16 miles ☐ 16 to 30 ☐ 31 to 45 ☐ 46 to 60 ☐ 61 to 75 ☐ 76 to 100
☐ 101 to 125 ☐ 126 to 150 ☐ 151 to 175 ☐ 176 to 200 ☐ Over 200

Vehicle type most often used for rural freeway trips:

☐ Sedan ☐ Sports car ☐ Pickup truck ☐ SUV ☐ Minivan
☐ Full-size van ☐ RV/Motorhome ☐ Motorcycle ☐ Other _______________

Typical number of passengers in vehicle for rural freeway trips?

☐ 0 – Driver only ☐ 1 ☐ 2 ☐ 3 ☐ 4 or more

Typical driving style on rural freeways (on a scale from 1-5, with 1 being 'Very Conservative' and 5 being 'Very Aggressive'): ________

When driving alone, versus driving with passengers, does your driving style become:

☐ Less aggressive ☐ Stay the same ☐ More aggressive

Your Opinions

Rank the overall quality of your trip (Excellent, Very Good, Good, Fair, Poor, Very Poor) for the given roadway and traffic conditions observed in each video clip. In the space provided, list all the significant factors/reasons that influenced your ranking of the trip quality for each video clip. After listing the factors, please number them from most significant to least significant (with 1 being the most significant).

Video Clip	Rank	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		

10		
11		
12		
13		

In general, how would the purpose of your trip (such as business, recreational, social) affect the trip quality rankings assigned above (e.g., higher, lower, not at all)?

If the conditions in the video clips were encountered in an urban setting, and the trip length was relatively short, how would this affect the trip quality rankings assigned above (e.g., higher, lower, not at all)?

How would you rate this exercise in terms of its ability to give you a reasonable feel for the traffic and roadway conditions you would experience if you were actually driving your vehicle along this roadway under these traffic conditions?

☐ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor ☐ Very Poor

APPENDIX D
SAMPLE LOOP DETECTOR DATA

Tag	County	Site	Lane	Year	Month	Day	Hour	Min	Int	15	23	28	33	38	43	48	53	58	63	68	73	78	83	91	Total Vol.	Avg. Spd[1]	5 min vol[1]	veh/hr/ln[1]	Density[1]
SPD	18	9920	1	04	03	08	00	05	005	0	0	0	0	0	0	0	0	2	1	3	4	3	1	1	15	72.2			
SPD	18	9920	2	04	03	08	00	05	005	0	0	0	0	0	0	0	0	0	0	0	2	5	1	0	8	77.4	23	138	1.86
SPD	18	9920	3	04	03	08	00	05	005	0	0	0	1	0	0	0	0	0	0	0	2	4	1	1	9	73.9			
SPD	18	9920	4	04	03	08	00	05	005	0	0	0	0	0	0	0	0	1	2	6	10	5	1	0	25	71.8	34	204	2.82
SPD	18	9920	1	04	03	08	00	10	005	0	0	0	0	0	0	0	0	1	2	3	3	7	2	0	18	73.3			
SPD	18	9920	2	04	03	08	00	10	005	0	0	0	0	0	0	0	0	0	0	0	3	6	1	2	12	79.3	30	180	2.38
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SPD	18	9920	4	04	03	08	00	10	005	0	0	0	0	0	0	0	1	0	1	5	10	4	1	0	22	71.9	37	222	2.99
SPD	18	9920	1	04	03	08	00	15	005	0	0	0	0	0	0	0	0	0	2	2	7	3	0	2	16	74.3			
SPD	18	9920	2	04	03	08	00	15	005	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	8	83.5	24	144	1.86
SPD	18	9920	3	04	03	08	00	15	005	0	0	0	0	0	0	0	0	0	0	1	7	5	1	0	14	75.1			
SPD	18	9920	4	04	03	08	00	15	005	0	0	0	0	1	0	0	0	2	5	8	7	4	1	0	28	68.5	42	252	3.56
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SPD	18	9920	2	04	03	08	00	20	005	0	0	0	0	0	0	0	0	0	0	4	0	3	0	1	8	74.6	28	168	2.35
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SPD	18	9920	4	04	03	08	00	20	005	0	0	0	0	0	0	0	0	0	4	4	8	12	0	0	28	73.0	45	270	3.65
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SPD	18	9920	3	04	03	08	00	25	005	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	4	80.5			
SPD	18	9920	4	04	03	08	00	25	005	0	0	0	0	0	0	0	0	0	1	7	2	5	0	0	15	71.7	19	114	1.55
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SPD	18	9920	2	04	03	08	00	30	005	0	0	0	0	0	0	0	0	0	0	0	3	2	1	0	6	76.3	24	144	2.01
SPD	18	9920	3	04	03	08	00	30	005	0	0	0	0	0	0	0	0	0	0	1	2	1	1	2	7	79.6			
SPD	18	9920	4	04	03	08	00	30	005	0	0	0	0	0	0	0	0	0	2	5	8	4	2	1	22	73.6	29	174	2.32
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SPD	18	9920	2	04	03	08	00	35	005	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	6	73.8	29	174	2.41
SPD	18	9920	3	04	03	08	00	35	005	0	0	0	0	0	0	0	0	0	0	0	3	2	4	0	9	78.6			
SPD	18	9920	4	04	03	08	00	35	005	0	0	0	0	0	0	0	0	0	1	7	11	8	0	0	27	72.8	36	216	2.91
SPD	18	9920	1	04	03	08	00	40	005	0	0	0	0	0	0	0	0	0	2	6	7	2	1	0	18	71.3			
SPD	18	9920	2	04	03	08	00	40	005	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	4	78.0	22	132	1.82
SPD	18	9920	3	04	03	08	00	40	005	0	0	0	0	0	0	0	0	0	0	0	1	4	1	2	8	81.3			
SPD	18	9920	4	04	03	08	00	40	005	0	0	0	0	0	0	0	0	2	2	3	7	6	1	1	22	72.7	30	180	2.40

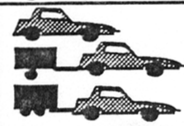
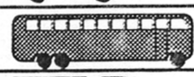
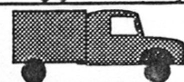
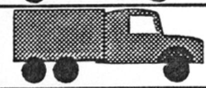
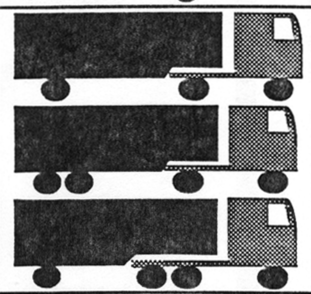
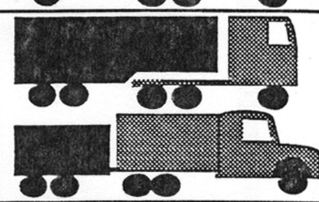
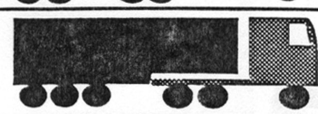
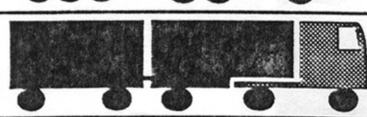
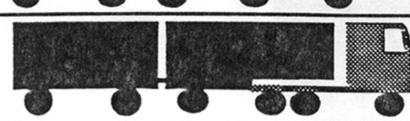
[1]These categories were calculated from the given loop detector data and added to the speed data spreadsheets.

Tag	County	Site	Yr.	Mo.	Day	Hour	Min	Int	Lane	#	Lane	#	Lane	#	Lane	#	Total NB	Total SB	Total Volume
CNT	18	9920	04	03	08	00	05	005	1	15	2	8	3	9	4	25	23	34	57
CNT	18	9920	04	03	08	00	10	005	1	18	2	12	3	15	4	22	30	37	67
CNT	18	9920	04	03	08	00	15	005	1	16	2	8	3	14	4	28	24	42	66
CNT	18	9920	04	03	08	00	20	005	1	20	2	8	3	17	4	28	28	45	73
CNT	18	9920	04	03	08	00	25	005	1	16	2	7	3	4	4	15	23	19	42
CNT	18	9920	04	03	08	00	30	005	1	18	2	6	3	7	4	22	24	29	53
CNT	18	9920	04	03	08	00	35	005	1	23	2	6	3	9	4	27	29	36	65
CNT	18	9920	04	03	08	00	40	005	1	18	2	4	3	8	4	22	22	30	52
CNT	18	9920	04	03	08	00	45	005	1	13	2	4	3	12	4	28	17	40	57
CNT	18	9920	04	03	08	00	50	005	1	8	2	4	3	14	4	29	12	43	55
CNT	18	9920	04	03	08	00	55	005	1	16	2	4	3	8	4	22	20	30	50
CNT	18	9920	04	03	08	01	00	005	1	12	2	3	3	4	4	24	15	28	43
CNT	18	9920	04	03	08	01	05	005	1	19	2	3	3	8	4	19	22	27	49
CNT	18	9920	04	03	08	01	10	005	1	6	2	2	3	8	4	25	8	33	41

Tag	County	Site	Lane	Year	Month	Day	Hour	Min	Int	CL 01	CL 02	CL 03	CL 04	CL 05	CL 06	CL 07	CL 08	CL 09	CL 10	CL 11	CL 12	CL 13	CL 14	CL 15	Total Vol.	Buses[1]	Trucks [1]	HV[1]	%HV [1]	Total % HV[1]
CLS	18	9920	1	04	03	08	00	05	005	0	4	5	0	0	0	0	0	5	0	1	0	0	0	0	15	0	6	6	0.4	
CLS	18	9920	2	04	03	08	00	05	005	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0.26
CLS	18	9920	3	04	03	08	00	05	005	0	6	2	0	0	0	0	0	0	0	0	0	0	0	1	9	0	1	1	0.11	
CLS	18	9920	4	04	03	08	00	05	005	0	9	1	0	0	0	0	0	13	0	0	0	0	0	2	25	0	15	15	0.6	0.47
CLS	18	9920	1	04	03	08	00	10	005	0	9	5	1	0	0	0	0	2	0	0	0	0	0	1	18	1	3	4	0.22	
CLS	18	9920	2	04	03	08	00	10	005	0	9	1	0	0	0	0	0	2	0	0	0	0	0	0	12	0	2	2	0.17	0.2
CLS	18	9920	3	04	03	08	00	10	005	0	11	0	0	0	0	0	0	3	1	0	0	0	0	0	15	0	4	4	0.27	
CLS	18	9920	4	04	03	08	00	10	005	0	5	4	0	0	0	0	1	10	0	1	0	0	0	1	22	0	13	13	0.59	0.46
CLS	18	9920	1	04	03	08	00	15	005	0	8	3	0	1	1	0	0	3	0	0	0	0	0	0	16	0	3	3	0.19	
CLS	18	9920	2	04	03	08	00	15	005	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0.13
CLS	18	9920	3	04	03	08	00	15	005	0	13	0	0	0	0	0	0	1	0	0	0	0	0	0	14	0	1	1	0.07	
CLS	18	9920	4	04	03	08	00	15	005	0	11	7	0	0	0	0	0	7	0	1	0	0	0	2	28	0	10	10	0.36	0.26
CLS	18	9920	1	04	03	08	00	20	005	0	9	3	0	1	1	0	0	6	0	0	0	0	0	0	20	0	6	6	0.3	
CLS	18	9920	2	04	03	08	00	20	005	0	6	0	0	0	0	0	0	1	0	1	0	0	0	0	8	0	2	2	0.25	0.29
CLS	18	9920	3	04	03	08	00	20	005	0	8	3	0	1	0	0	0	5	0	0	0	0	0	0	17	0	5	5	0.29	
CLS	18	9920	4	04	03	08	00	20	005	0	7	3	0	1	0	0	1	16	0	0	0	0	0	0	28	0	17	17	0.61	0.49
CLS	18	9920	1	04	03	08	00	25	005	0	8	0	0	1	0	0	0	6	0	0	0	0	0	1	16	0	7	7	0.44	
CLS	18	9920	2	04	03	08	00	25	005	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0.30
CLS	18	9920	3	04	03	08	00	25	005	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	
CLS	18	9920	4	04	03	08	00	25	005	0	5	2	0	0	0	0	1	7	0	0	0	0	0	0	15	0	8	8	0.53	0.42
CLS	18	9920	1	04	03	08	00	30	005	0	9	2	0	0	1	0	0	5	0	0	0	0	0	1	18	0	6	6	0.33	
CLS	18	9920	2	04	03	08	00	30	005	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0.25
CLS	18	9920	3	04	03	08	00	30	005	0	2	4	0	1	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	
CLS	18	9920	4	04	03	08	00	30	005	0	9	2	0	1	0	0	0	10	0	0	0	0	0	0	22	0	10	10	0.45	0.34
CLS	18	9920	1	04	03	08	00	35	005	0	12	1	0	1	0	0	0	9	0	0	0	0	0	0	23	0	9	9	0.39	
CLS	18	9920	2	04	03	08	00	35	005	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0.31
CLS	18	9920	3	04	03	08	00	35	005	0	5	3	0	0	0	0	0	1	0	0	0	0	0	0	9	0	1	1	0.11	
CLS	18	9920	4	04	03	08	00	35	005	0	9	2	0	1	0	0	1	13	0	0	0	0	0	1	27	0	15	15	0.56	0.44

[1]These categories were calculated from the given loop detector data and added to the class data spreadsheets.

CLASSIFICATION SCHEME "F"

CLASS. GROUP		DESCRIPTION	NO. OF AXLES
1		MOTORCYCLES	2
2		ALL CARS CARS W/ 1-AXLE TRLR CARS W/2-AXLE TRLR	2 3 4
3		PICK-UPS &VANS 1 & 2 AXLE TRLRS	2, 3, & 4
4		BUSES	2 & 3
5		2-AXLE, SINGLE UNIT	2
6		3-AXLE, SINGLE UNIT	3
7		4-AXLE, SINGLE UNIT	4
8		2-AXLE TRACTOR, 1-AXLE TRLR(2S1) 2-AXLE TRACTOR, 2-AXLE TRLR(2S2) 3-AXLE TRACTOR, 1-AXLE TRLR(3S1)	3 4 4
9		3-AXLE TRACTOR, 2-AXLE TRLR(3S2) 3-AXLE TRUCK, W/2-AXLE TRLR	5 5
10		TRACTOR W/ SINGLE TRLR	6 & 7
11		5-AXLE MULTI-TRLR	5
12		6-AXLE MULTI-TRLR	6
13	ANY 7 OR MORE AXLE		7 or more

System Usage Data 1/9/90

BIOGRAPHICAL SKETCH

David S. Kirschner is a 23-year old graduate student at the University of Florida. He is studying towards his Master of Engineering degree, specializing in transportation engineering. He received a Bachelor of Science in Civil Engineering degree from the University of Florida in December of 2004.